SCOTTISH HOSPITALS INQUIRY

Bundle of documents for Oral hearings commencing from 19 August 2024 in relation to the Queen Elizabeth University Hospital and the Royal Hospital for Children, Glasgow

Bundle 16 - Ventilation PPP

SCOTTISH HOSPITALS INQUIRY

Table of Contents

Scottish Health Planning Note 04

In-patient accommodation: Options for choice

NHS in Scotland, P&EFEx, May 2000

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Contents

A47851278

About this series

The Scottish Health Planning Note series is intended to give advice on the briefing and design of healthcare premises in Scotland.

These Notes are prepared in consultation with representatives of the National Health Service in Scotland and appropriate professional bodies.

Health Planning Notes are aimed at multidisciplinary teams engaged in:

- designing new buildings;
- adapting or extending existing buildings.

Throughout the series, particular attention is paid to the relationship between the design of a given department and its subsequent management. Since this equation will have important implications for capital and running costs, alternative solutions are sometimes proposed. The intention is to give the reader informed guidance on which to base design decisions.

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1. Scope of SHPN 04

1.1 This Scottish Health Planning Note (SHPN) provides guidance on the planning and design of hospital accommodation for people with acute illness or who require an acute intervention. It replaces SHPN 4 Adult acute wards (1992). The guidance in this Note can be used either to inform the decisions made during the planning of a project or for evaluating a design solution.

1.2 Services for people with acute illness may be delivered in a variety of locations. These include care at home managed by primary healthcare, community health service or hospital outreach teams; day facilities at local health centres, community hospitals or acute hospitals or in-patient accommodation in community, acute general or specialist hospitals. This Note offers guidance for adult in-patient accommodation in acute general hospitals. Guidance on facilities for other modes and types of care is provided in other documents in the Scottish Health Planning Note series.

The rationale for review

1.3 There have been profound changes in the organisation, delivery and practice of bedside care since 1992 when the NHS in Scotland issued the last guidance on the adult acute ward. In clinical practice new technologies have resulted in an in-patient population which has a rapid turnover with a high number of interventions and a high dependence on services (medical gases, electrical/electronic) and on staff.

1.4 The emphasis on the efficient use of resources has led to high bed utilisation not simply to maximise the use of the bed itself, but to gain the greatest value from the more costly elements of the hospital complex, the diagnostic and therapeutic facilities, imaging and operating departments.

1.5 The organisation and use of the most valuable resource – the knowledge, skills and expertise of staff – is being scrutinised, reviewed and subjected to new standards. This includes the working hours of doctors, the removal of the untrained worker, etc. Different organisational practices are being implemented: multi-disciplinary teams, care groups, multi-skilled generic workers, and professional accountability with flat management structures to name but some.

1.6 The use of computerised systems to hold, process and transfer patient information both digitally and by video at every point of clinical activity is rapidly becoming a reality – reducing the need for personal staff-to-staff interaction, proximity to specialised inputs and a multiplicity of paper-held records.

1.7 Adjacency of some areas with others becomes less significant when information is accessible throughout a system. The use of technology to manage and manipulate information relating to patients also supports organisational change in professional practice. Whilst hands-on skills and expertise cannot yet be substituted, the body of up-to-date professional knowledge is no longer limited to committed professionals but is widely available to anyone – including the lay public – through computer-held databases.

1.8 Telemedicine in its widest definition is "the investigation, monitoring and management of patients and the education of patients and staff, using systems which allow ready access to expert advice and relevant patient information, no matter where the patient is located". This will have a significant impact on the configuration of healthcare services, within the hospital as well as between one location and another.

1.9 The most notable change in today's society is the public's own increased expectations about the quality of the delivery of services – whether in the public or private sector. These expectations are reflected in the NHS in Scotland Patient's Charter – Charter for Health, which set out people's rights in the NHS and the minimum standards to be expected from all health services.

1.10 People attending a healthcare facility for assessment, diagnosis, treatment or care expect:

- to be able to find their way around the facility easily from clear signposting;
- to have greater consultation and discussion (in confidence) with those responsible for their health care;
- that interventions or bodily functions will be performed in private and that they will not be visible to or within earshot of others;
- that there will be sufficient flexibility to enable the patient's religious and cultural beliefs to be upheld;
- that the environment will be not only safe, clean and hazard-free, but will have a pleasant ambience.

It should be possible for people to be able to alter the environment to suit themselves. All these expectations have an impact on in-patient accommodation.

2. Service objectives

Introduction

2.1 The essential message is the ever-increasing rapidity of change in the function and utilisation of hospitals. Flexibility in use on both a day-to-day basis and over time is the key to economic, efficient provision. The capacity to accommodate patients with different needs simultaneously and over a period must be the first criterion.

2.2 In the light of today's concerns a greater emphasis on the human needs of patients is required without jeopardising health outcome or a loss to the efficiency of the hospital.

2.3 There is a close similarity between the different sets of criteria used by authorities in assessing and evaluating hospital design overall. The criteria are readily applicable to in-patient areas alone, to ensure the appropriate balance between the efficiency of the hospital, the effectiveness of health care and that the human needs of individuals are met.

The desirable environment

2.4 The following table summarises the key criteria of a desirable environment:

Space for	
	clinical activity at the bedside. clinical activity elsewhere. storage/display of patients' possessions. storage of bulky equipment. staff support and training. social support of patient
Suitability of	
	services and supplies at the bedside for clinical activity. access to and within area for physically and sensorially impaired people. services to enable personal communication by patient. services to enable direct admin/clinical communication from the bedside. a reassuring, stress reducing, environment. a safe and hazard free facility.

Privacy	
	during clerking and clinical discussions between patient and staff. during clinical treatment. for bodily functions and personal care. for personal discussions and telephone calls. for staff communications. for staff rest and beverage breaks.
Choice, control, comfort	
	to be alone or in company, including visitors. of temperature, ventilation, lighting and sound. of diversion, outlook, entertainment. with access to beverages for patients and relatives. with local storage of personal belongings of staff. with access to the outside world.

2.5 A particular focus of concern has been the “mixed-sex” ward in which the needs of patients for privacy and dignity have taken a lower priority than the interests of efficiency and clinical effectiveness. Although no fixed definition has been given, it is assumed to be one where men and women may be in adjacent beds or use common washing and sanitary facilities. This form of use of accommodation has become more common, as the drive for the efficiency represented by high levels of occupancy and the demand for high throughput generated by the waiting times initiatives have taken effect. Ad hoc comment, surveys and pressure groups all emphasise the public distaste for the “mixed-sex” ward concept, particularly non-segregated sanitary facilities. This is of such concern that the guidance in this Note has been developed to ensure that all future in-patient areas, including sanitary facilities, should be for single sex occupation only.

2.6 However a range of surveys and studies demonstrate that concerns embrace many more issues than the lack of privacy and dignity associated specifically with ‘mixed-sex’ wards. The levels of sensory stimulation - noise in particular -disturbing rest and sleep, inadequate numbers of bathrooms and lavatories, inability to alter lighting and temperature are among those issues repeatedly occurring. Capturing local views and wishes at the outset, throughout the design stage and when evaluating the finished design is important: people value the opportunity to comment at all stages of development.

Flexibility, efficiency and economy in the use of beds

2.7 When putting together the brief for in-patient ward accommodation in an acute general hospital, local priorities and preferences in regard to clinical emphasis and organisation of care delivery play an important role in determining the nature and design of the facility.

2.8 Whilst this document does not discuss the relevant merits of different organisational models, it is nevertheless necessary to recognise that different models of organising patient care are being developed and that the physical environment should enable and not inhibit the adoption of new organisational models**.** The principles of flexibility, efficiency and economy in the use of beds should, however, not be abandoned and ward accommodation must be arranged to also satisfy these basic planning parameters.

2.9 This Note engages these parameters by offering “mix and match” options for generating in-patient accommodation that should meet most local priorities including the reuse of existing accommodation. The ultimate aim is to provide a selection of spaces that may be combined in different ways to create an environment appropriate for today’s needs and which may be readily suitable for tomorrow’s.

2.10 The “mix and match” modular approach is particularly useful as new service patterns develop. It enables the easy aggregation of spaces to provide a variety of accommodation for in-patients either as part of a specialist patient focused department, day surgery and small in-patient areas, an admission/short stay facility in association with an accident and emergency department or a large in-patient floor.

2.11 The levels at which management communication and information systems operate, and the extent to which these alter throughout a 24-hour period influence the location of the clinical and administrative areas. Allied to this are decisions on the extent and location of staff facilities.

Person-centred, service-focused bed space

2.12 The starting point for the consideration of spaces to generate the modules is the person-centred, service-focused bed space. From decisions taken on the nature and size of the bed space flow consequences for spaces for clinical treatment and storage, staff workstations, patient social spaces and meeting/discussion/interview spaces.

2.13 In an acute hospital today, the volume of activity that centres on the patient in or at the bedside is increasing. The period that a patient spends in hospital is shortening, and becoming limited to that part of a package of healthcare that requires active interventions for diagnosis, treatment and immediate recovery. The level of dependence and disability of patients once interventions begin until discharge is relatively high; movement by staff around the patient may be considerable and there is likely to be a high use of equipment and aids at the bedside. The activities and the patient’s response to interventions are recorded, increasingly on computer held databases.

2.14 There are three distinct categories of direct activity that take place:

1. clinical treatment and care:

- admission, with the intimate discussion of personal matters;
- specific medical and nursing interventions and observation;
- rehabilitation;
- teaching and training the patient and relatives;
- informing, discussing, listening and advising.

2. personal care and maintenance:

- eating, drinking, washing and toileting;
- entertainment/diversion, reading, watching the television;
- socialising;
- receiving visitors.

3. support activities:

- preparation of clinical procedures;
- maintaining records;
- holding stores;
- communicating;
- developing staff skills.

2.15 Single-bed room accommodation remains relatively rare in the UK National Health Service, although it is common practice in the private sector. In the USA and some of the European countries there are more single-bed rooms than multi-bedded areas in acute care hospitals.

2.16 Single-bed rooms provide complete flexibility of use for patients of gender, any age, and most clinical conditions including source isolation. This increases the opportunity for shortening turnover intervals and thus raises annual average occupancy. Single rooms offer privacy for treatment and personal activities, confidentiality of discussion, quiet for sleep and rest. Patients can control the environment, have visitors without disturbing others and can venture the short distance from bed to bathroom in relative safety without having to negotiate past other patients and staff and the general paraphernalia of a busy acute area. When the room is used to hold the necessary supplies for a patient's daily care needs, staff travelling distance and time is reduced.

2.17 Arguments presented against the single-bed room are the increase in the overall floor area (and consequential increase in capital cost), difficulty in observing patients and that patients feel lonely**,** increase in staffing (and consequential increase in revenue costs). There is some degree of validity to these arguments. However, the balance of the evidence indicates that the advantages outweigh the disadvantages.

Clinical responsibility

2.18 The ward generally reflects the span of clinical responsibility covered by a Sister/Charge Nurse. From time to time, the span of clinical responsibility of an individual Sister/Charge Nurse may be bigger or smaller than the size of the actual ward: it may change from as few as 12-18 beds to as many as 30-36 beds. It is therefore essential that wards are planned to permit the flexible use of accommodation by effective nurse charges based on patient requirements. In practice a number of wards may be combined to form a unit, which can range in size from 96-120 beds with supporting rooms; this usually reflecting the span of management and clinical responsibility of a clinical nurse manager. The design of the ward must permit the flexible use of the accommodation and this is determined by clinical need, resources available and nurse management patterns adopted.

Grouping of patients

2.19 Patients should be grouped according to their degree of illness and the extent of their nurse dependency. Advances in medical and nursing practice, including the development of medical technology have, in recent years, led to shorter average lengths of stay in acute wards. As well as the resulting increased turnover, an increase in the proportion of elderly and very elderly patients admitted has meant that the majority of patients at any one time in a typical acute ward could be categorised as being of high dependency. Within this category of high dependency, two levels of care can be identified:

- *Intensive Therapy*

  In acute accommodation, Intensive Therapy is required by a small but significant number of patients who require active care 24 hours per day from both medical and nursing staff and the use of life supporting equipment. This Note does not cover such accommodation.

- *Intensive or concentrated nursing care*

  This care is required by an increasing number of patients in every acute ward. Some Boards claim that 50% or more of patients are in this grouping and require 24 hours per day concentrated nursing care, but not constant medical care. In order to provide continuity of care and to make the best use of equipment and nursing resources, these patients may be grouped in one or more of the wards to form a unit. Alternatively, if nursing management and resources are so structured, these patients may be nursed in single-bed rooms or grouped in multi-

bed rooms. To achieve high occupancy levels and to meet the fluctuations in daily demand for intensive care beds, wards must have a direct relationship one with another. By this means the size of the nursing charge can vary according to patient needs. Nursing management will ensure maximum utilisation of staff and ensure that they are deployed to meet changing requirements throughout the day and night. Clearly the design configuration of the ward must be such as to meet this demand.

Grouping of beds

2.20 The decision to plan accommodation within a range of single and multi-bed rooms requires careful thought. A ward with all single rooms will involve an increase in the size of that ward, along with difficulties in supervision, problems of communication and an increase in staffing resources required. The proportion of beds in any one ward provided as single rooms must be determined by local factors and policy. Single-bed rooms should be used to accommodate patients who are:

- liable to infect others;
- particularly susceptible to infection;
- seriously ill and dying;
- likely to disturb others;
- requiring special attention (needing special apparatus or quiet conditions);
- Patients who need privacy.

The remaining beds should be grouped in twos and fours. The preference is for four bedrooms as each patient has a corner bedspace.

Acute specialities suitable for this type of accommodation

2.21 **General Medicine:**

- Haematology;
- Rheumatology;
- Respiratory Diseases;
- Cardiology;
- Nephrology;
- Rehabilitation Medicine;
- Dermatology.

2.22 **General Surgery:**

- Orthopaedic Surgery;
- Gynaecology;
- ENT;
- Ophthalmology;
- Urology;
- Oral Surgery/Medicine.

2.23 **Supra Area Specialities:**

- Medical Neurology;
- Oncology;
- Plastic Surgery;
- Macillo Facial Surgery.

Control of infection

2.24 Prevention of cross-infection is fundamental to patient care. All wards should comply with the recommendations of the Scottish Infection Manual. The principal ways in which design may help in the control of cross-infection are:

- by the provision of single rooms and multi-bed rooms;
- by the provision of accommodation designed to facilitate safe practice; and
- depending on local needs and policies, some isolation may be needed to minimise the risk of cross-infection. Immuno-compromised patients may require to be nursed in a positive pressure environment, while patients who present a risk of infection to others would normally be nursed in a negative pressure environment. Where necessary up to 4 single-bed rooms in each 24 bed ward should be mechanically ventilated to enable either positive or negative pressurisation. The environmental standards are detailed further in Chapter 5.

Health and safety

2.25 The requirements of relevant sections of the document ‘The Control of Substances Hazardous to Health - Guidance for the lnitial Assessment in Hospitals’ 1994 should be adopted.

Hospital clinical and operational policies

Catering

2.26 Each ward should have facilities for serving meals to patients in accordance with the hospital's catering policy. These facilities should comply with current food hygiene and safety legislation, for example the 'Food Safety Act, 1990' and the 'Food Hygiene Amendment Regulation, 1990'.

2.27 Two common methods of meal delivery service are:

- **central tray service** – meals which have been assembled to the individual patient's requirements and delivered to the ward in a trolley with the food kept hot by a heat retaining base under each plate or in a heated tray trolley. On arrival at the ward, meals are served at the earliest opportunity. Space should be provided to accommodate the delivery trolley without obstructing normal circulation;
- **cook-chill service** – chilled meals which have been assembled to the individual patient's requirements and delivered to the ward in a trolley. This may incorporate a reheating compartment, or a separate reheating unit may be provided at ward level or in a shared trolley holding room. Meals must be stored and heated under controlled conditions before being served to patients. Space, in addition to that needed for the bulky delivery trolleys, must be provided for activities associated with the controlled reheating process – for example temperature monitoring. An electric power supply will be needed.

Domestic services

2.28 The accommodation required for storage and cleaning of domestic equipment at ward level will be determined by the scope and extent of the service as outlined by the Hospital's operational policies.

Supply, storage and disposal

2.29 The concept of Materials Management involves the supply, distribution, storage and disposal or re-cycling of a wide range of goods and equipment essential to the efficient management of wards. The range of items is provided by a number of different hospital departments.

These include:

- Central Store;
- Sterilising and Disinfecting Unit;
- Pharmacy;
- Laundry;

- Kitchen;
- Laboratory;
- Engineering Services.

The methodology adopted by the hospital to provide an effective Materials Management System requires detailed planning and co-ordination.

2.30 The storage space required for supplies is influenced by three principal factors:

- **Type**: medical surgical sundries, sterile supply service items, pharmaceutical supply, etc;
- **Quantity**: proportional to patient throughout;
- **Policy**: the whole hospital policy determines the frequency of delivery of each type of supply.

2.31 The space provided should be sufficient to hold that quantity of each item that will match the expected demand for the longest period of time between consecutive deliveries. In practice this means making space available for holding not less than five days' supply.

2.32 The consequences of supply, storage and disposal policies for capital, revenue and service all interact. Increasing space and stock increases both capital and revenue costs. Reducing space reduces capital outlay but demands an increase in the frequency of delivery, so that running costs also increase. Insufficient stock can adversely affect patient care and nursing service because staff are distracted by the necessity of seeking or collecting the items required. Also, an unreliable supply encourages defensive overstocking.

2.33 Disposal of pressurised containers requires special attention – see SAB(88)79 'LPG Aerosol Containers: Risks arising from storage, use and disposal'. Specifically constructed containers (see Specification No. TSS/S 330, 15 December 1982) should be used for 'SHARPS' particularly needles. This minimises the risk of injury to staff, particularly portering staff, handling goods destined for incineration.

Figure 1

Purpose and siting of departmental stores									
Activity / Space	Storage / holding Categories of items to be stored								
	Medical and surgical inc IV fluids	Pharmacy/ lab. reagents	Controlled drugs	Clean linen	Catering supplies	Stationery	House-keeping/ cleaning supplies	Mobile medical equipment	Furniture – bulk items
Staff base						●			
Bed areas	●							●	
Bulk supplies store	●						●		
Furniture store									●
Clean utility	●	●	●						
Linen store				☐					
Dirty utility									
Clinical equip-ment store								●	
Laboratory		●							
Workshop									
Staff changing				●					
Staff rest room/ pantry					●				
Patient pantry					●				
Relatives' pantry					●				
Offices						●			
Seminar room						●		●	
Cleaner's room							●		

Activity spaces not used for storage

Entrance/waiting area

Disposal room

On-call room

Equipment service room

Key

● store

☐ policy option could be linen trolley

Information handling

2.34 Computing expertise is now widely available in the NHS and users should ensure that, at an early stage, they inform themselves of current and projected local computing policies and prepare their proposals accordingly.

Staff changing

2.35 Changing facilities for male and female staff may be provided centrally, zonally, or locally (SHHD/DS(1984)29, Nucleus Study No. 12 ‘Staff Change (Options)’ and Nucleus Study 13 ‘Decentralised-zonal staff change’). Ward facilities should complement those provided elsewhere.

3. Specific functional and design requirements

Introduction

3.1 The “mix and match” modular approach discussed in paragraphs 2.7 to 2.11 is developed in this Chapter which details individual module and room requirements. There are five modules of accommodation:

- bed and sanitary facilities;
- patient support facilities;
- storage spaces;
- utilities;
- administration areas and staff facilities.

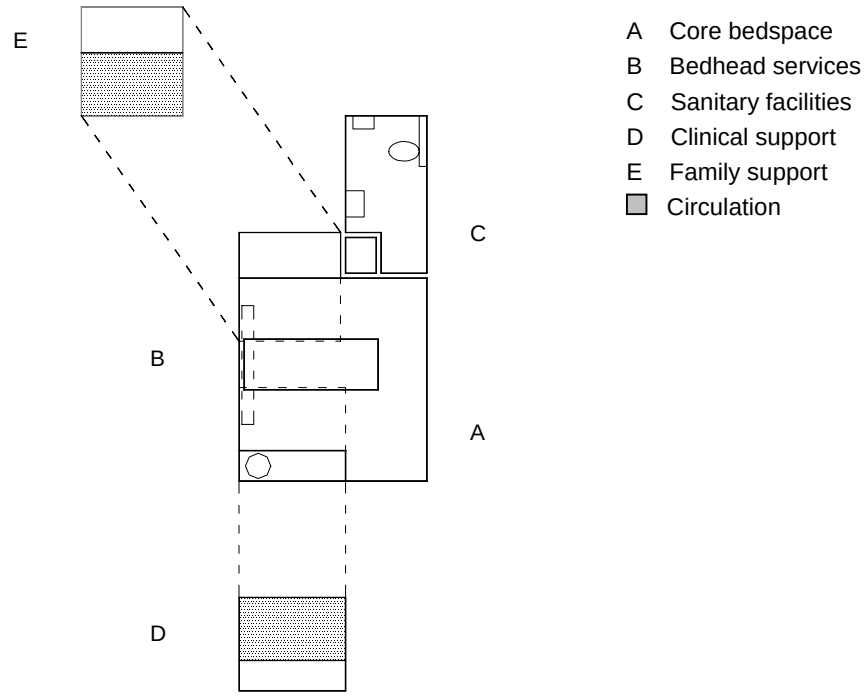
In addition, essential complementary and optional accommodation is offered.

3.2 Modules may be aggregated as packages for the level of provision required.

Bed and sanitary facilities

3.3 This Note provides design guidance for both single-bed and multi-bed rooms. The diagram below shows the zones required to enable the full range of activities to take place around a bedspace in a single-bed room.

Five activity zones within a bedroom



Single-bed rooms

3.4 The single-bed rooms should be sized to enable the range of bedside activities appropriate to the needs of the project. These could include:

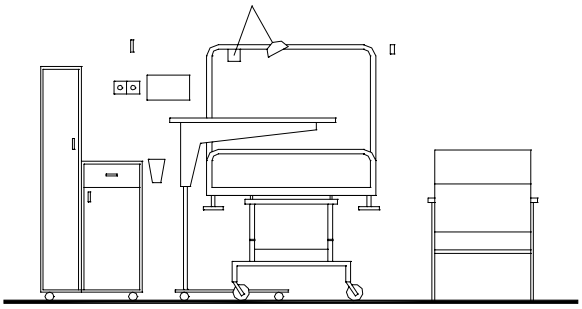
- family involvement in the care team;
- bedside diagnostics and the recording of information;
- local ancillary and support services at the bedside;
- clinical support;
- family support.

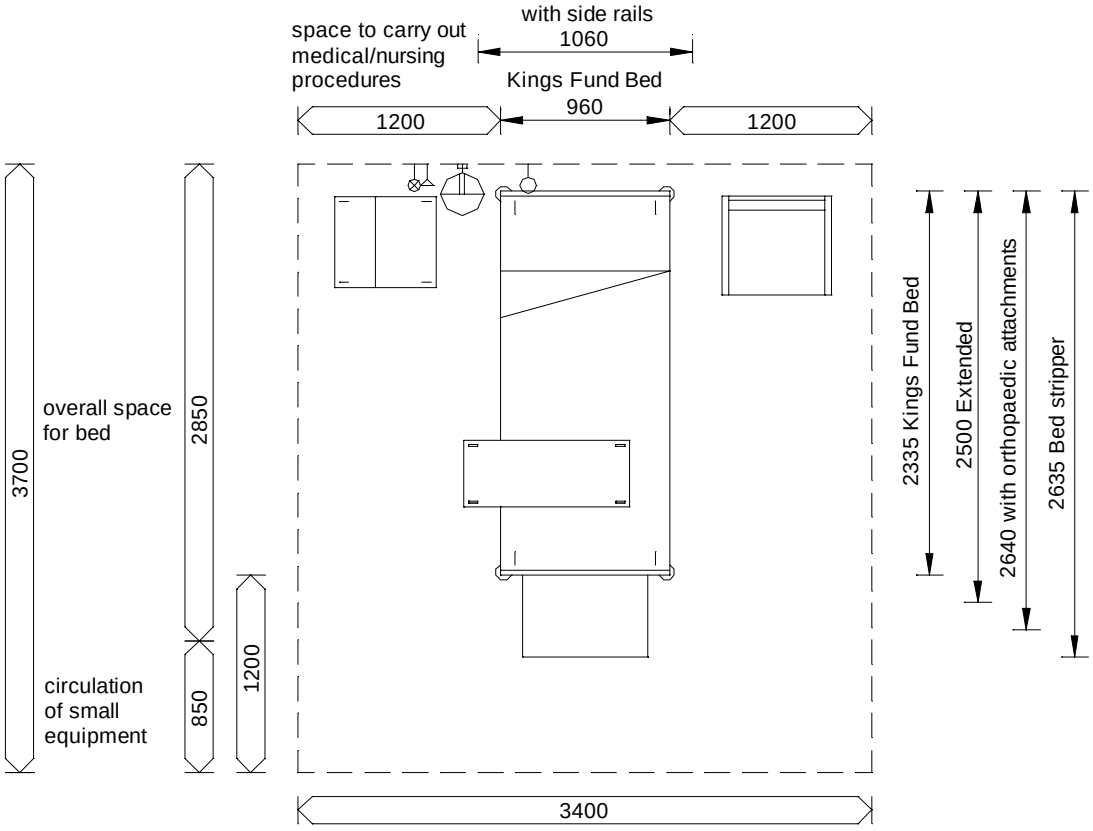
The extent to which these activities are required in individual cases will depend on the nature of the intervention and care involved. In some cases space requirements could be minimal, while in others space more akin to an HDU may be needed. In the interest of economy, it is suggested that Trusts consider adopting a range of room sizes geared to the likely requirements of the project in hand and which will provide flexibility in use. In this regard two bedded rooms are included in the Schedules of Accommodation because they can provide a flexibility of use not always available with single-bed accommodation.

3.5 The single-bed room should allow procedures to be carried out from either side of the bed with adequate circulation space so that medical emergency teams and equipment, including patient lifting aids, can gain access to the patient. There should be adequate space for moveable furniture and unobstructed access for wheelchairs. Space to accommodate overnight visitors should be provided in an appropriate number of rooms to reflect the anticipated requirement. A fold-down bed or bed/seat arrangement may be a suitable way to provide a sleeping facility.

3.6 The need to provide a variety of single-bed room sizes and the likely addition of clinical and family support zones to the bedspace will result in an increase in room size from the previous single-bed room with sanitary facilities area of 15.5m^2 (SHPN 4, 1992). The extent of the increase will be determined by the decisions taken regarding numbers and types of rooms required. The range of room size may vary between 18.0m^2 (no clinical and family support zones) and 30.0m^2, the latter allowing maximum space for all equipment and services including special beds, monitoring equipment, lifting hoists, etc. For planning purposes this Note adopts an average single-bed room area of 21.0m^2.

Core bedspace for single-bed room
(See paragraph 3.9 for multi-bed room dimensions.)





Dimensions are based on a standard Kings Fund bed including all extensions. Easily understood controls for the bed, TV, lights, and nurse call with pressure-sensitive control buttons, accessible with either hand, should be provided.

Minimum clearance of 1200mm should be allowed on both sides of the bed for clinical and support activities. This clearance should be maintained at the end of the bed whilst allowing for bed extensions and for tilting.

Multi-bed rooms

3.7 The alternative to a single-bed room is a multi-bed room, in which the different activity zones move to a greater or lesser degree further away from the bedside, and may be shared to support all the beds in the multi-bed room. To complete the range of room sizes proposed in 3.4 it is suggested that, if appropriate, Trusts use 2 or 4 bed rooms, each with designated sanitary facilities accessed not from within but from just outside the sleeping area. Each patient has a corner to provide a “home base”, the distance to washing and lavatory facilities is still short, but has the advantage of not being under the gaze of one’s immediate fellow patients.

3.8 Whether in a single- or a multi-bed room all bed spaces should be provided with:

- a variable-height bed;
- a bedside locker (or locker wardrobe);
- an overbed table;
- an easy chair and space for an additional stacking chair;
- a bedhead luminaire;
- a bedhead services panel incorporating:
  - electrical socket outlets;
  - shaver socket;
  - luminaire control switch;
  - staff call reset button/indicator lamp;
  - staff/staff emergency pull switch;
  - socket for patient handset;
  - patient handset storage bracket;
  - radio/TV;
  - stethoscope headset outlet (may be on handset control unit);
  - telephone/call monitoring;
  - IT point;
- a patient handset control unit incorporating:
  - staff call button;
  - reassurance light;
  - luminaire switch;
  - radio/TV volume control knob;
  - radio/TV selector switch;
- oxygen, vacuum outlets, etc;

- compressed air outlets (optional);
- personal storage:
  - a wardrobe with clothes hangers, lockable drawer, hooks, space for suitcase, shoes and boots is required. A further lockable drawer for medication should be incorporated.

  Space will be required for storing:
  - toiletries;
  - reading material;
  - writing supplies;
  - radio;
  - flowers;
  - cards;
  - non-perishable food;
- IT point;
- storage for a day's supply of linen and surgical goods/supplies;
- waste disposal (clinical and domestic).

3.9 Where not in a single-bed room each bedspace should not be less than 3.0m x 2.7m and be separable by curtains to provide a degree of privacy. Curtains should be shadow-proof, flame retardant, and if suspended from ceiling track, have a net or scalloped inset heading to ensure ventilation and light when drawn.

3.10 Each multi-bed room should include a wash-hand basin for staff use, a workstation and storage for a day's supply of linen and clinical goods. Each bed should have its own IT point

3.11 All bedrooms, whether single or multi-bed rooms, must be fitted with fire doors to comply with NHS in Scotland Firecode.

3.12 Each multi-bed room should include or have easy access to a sitting area, as the majority of patients, although highly dependent, are encouraged out of bed.

Sanitary facilities

3.13 All single-bed rooms and multi-bed rooms should have en suite WC and shower. The increasing acuity of illness of in-patients means that a great proportion of patients may use a wheelchair or require assistance during their hospital stay even when not normally wheelchair users. For greatest flexibility of use all sanitary facilities should be accessible and manageable by people with physical or sensory disabilities with or without assistance.

3.14 Easy access, convenient location and good design of WCs and other sanitary facilities are of great importance to patients. All assist the maintenance of independence and reduce the incidence of side effects from immobilisation. WCs should be clearly identified, and designated for use by people of one gender at a time, as needs fluctuate.

3.15 In each single-bed room there should be a WC and a shower as well as a wash basin for use by patients. Non-tap wash basins with motion sensors may be considered. For economy of space these facilities should be contained in one compartment per bedroom. It must be possible for sani-chairs to be pushed easily and without turning, into WC compartments. The wet shower area of the compartment should be separated by a curtain from the remainder which should serve as the drying area. There should not be a step between the wet and dry areas, but there is a requirement for sufficient slope of the floor to the outlet, so as to ensure proper drainage and prevent spillage of water into the dry areas. A separate wash-hand basin with lever taps for use by staff should be provided within the clinical support area.

3.16 In multi-bed rooms it is convenient to provide a separate WC compartment and a shower compartment both opening off a lobby from the bedroom. Thus two people may use the facility at once and one person showering does not prevent others from using the WC. However privacy and dignity must be ensured with the provision of appropriate security devices, locks, etc but with emergency access. Each compartment should have a wash basin. In the shower compartment there must be no step between wet and dry areas (the latter will contain the wash basin) but there must be sufficient slope to confine the water to the wet area. Both compartments should permit assisted use when required and have sufficient space for drying and dressing.

Shower and bathrooms

3.17 As public experiences widen and attitudes change, there is a greater acceptance of showers. The space economy of showers particularly when compared to assisted bathrooms is considerable. Apart from space, showers are efficient users of water and energy, easier and safer in use for both patients and staff and are said to be less likely to be a source of infection. However, shower compartments must be large enough to allow wheelchair access and it must be possible to shower patients on a suitable chair. A longer shower hose may be required. These factors should be considered by project teams in coming to a decision on the nature of washing facilities to be provided.

3.18 If centrally located, WCs should not be more than about 12m from bed areas or the day room. The following points should also be taken into account:

- all WCs must have provision for handwashing;
- as patients may wish to use the WC before or after bathing or showering, project teams should consider providing a WC and wash basin in each bathroom/shower room;
- at least one assisted WC should be so designed that staff can assist the patient from either or both sides.

3.19 A member of staff must be able to leave the WC without exposing the patient to view, and if privacy cannot be ensured by room design then an internal curtain or screen must be fitted.

3.20 Where a bath or shower is provided en suite to each multi-bed room, a centrally located assisted bathroom will also be required. If no baths are provided in en suite facilities, then at least one standard bath must be provided for general use in addition to the assisted bathroom.

3.21 The cord of the patient staff call system should be easily identifiable, accessible from the wet area, and descend far enough to be within the reach of a patient who has fallen or collapsed. The floor surface should be slip-resistant. The gradient of the floor of the wet area should ensure effective drainage to the waste outlet to prevent ponding. Ventilation should preclude excessive heat, humidity and odours.

Bidet

3.22 Provision of a bidet in the assisted bathroom or assisted shower should be considered; additional bidets may be required in wards serving particular clinical specialities.

Patient records

3.23 As with the single-bed room, the closer the facilities for maintaining records and holding supplies, the less time is spent by staff in travelling to and fro. A work station and storage trolley bay for linen and clinical supplies should be within or closely associated with the multi-bed room. Patients' case notes should be kept in a lockfast compartment or trolley.

Patient support facilities

3.24 The multi-bed room, however, cannot afford privacy for discussion of personal or clinical matters or for clinical treatment. If multi-bed rooms are used there must also be quiet separate rooms for consultation and examination or treatment and for one-to-one discussions, interviews or education.

Consultation/examination/treatment room

3.25 A consultation/examination room may be used for procedures of a clinical nature, as well as for pre-admission assessment, clerking and examination of patients on admission. A computer terminal should be provided at the desk to enable direct input to a patient's record, ordering investigations, etc.

3.26 If a patient who has not been allocated a single-bed room requires treatment, it may take place here. The patients may be ambulant, in a wheelchair, on a trolley, or on a bed; the door width must be sufficient to permit their passage. Door swings should not impede movement or activities within the room. All-round access to the patient on the examination couch is essential (which should be screened to ensure privacy). The examination couch must be mobile so that it can be moved out of the way to allow access to patients who need to be treated on a patient trolley or bed.

3.27 A desk and chairs for consultation are required. A small cupboard with a worktop, for the storage of items of equipment and sterile packs, is desirable.

3.28 This room should be equipped with terminal units for oxygen and for vacuum, an X-ray viewing facility, a mobile lamp, a deep sink and clinical hand washing facilities. Clinical-quality colour rendering light sources should be provided with appropriate dimming/enhancing facilities and walls, ceilings and floors should be of suitable colour and reflection. Natural ventilation will be required unless the department is deep planned where air conditioning may be needed.

Interview/sitting room

3.29 Discussions, assessments and education of patients or relatives with or by staff, therapists, social workers or relatives may be carried out in an interview/sitting room. These should be quiet and distraction-free to enable one-to-one communication. The same rooms may also be used by staff for staff interviews, appraisal and counselling.

3.30 The designer should aim to create an environment which is cheerful, comfortable and warm. Appropriate lighting and decorative textures such as pictures and plants can provide a tasteful domestic atmosphere. Finishes and furniture will have an important influence on the room. Easy chairs, a bookcase and coffee tables should be provided. It is important for rooms in which patients will be sitting to be free from draughts.

Day spaces

3.31 For patients – whether in single-bed rooms or multi-bed bays – open yet intimate areas recognisably intended for casual meeting and talking may be all that is required to enable patients who wish to socialise without the provision of dedicated day rooms which do not always provide an environment that people like to use. However the dedicated day room, in addition to its intended function, can be useful as a multi-purpose area, for example as a smoking area if limited smoking is allowed in the hospital, or as a holding area for patients who cannot go home until later in the day, thus releasing a bed space for more urgent use.

Pantry/beverage making

3.32 The pantry should be equipped with facilities for:

- the preparation of beverages and light snacks;
- the filling of patients' water jugs;
- storage of dry goods, and a limited amount of crockery and cutlery;
- refrigeration of perishable food.

3.33 A mechanical dishwasher and separate facilities for washing-up and hand-washing are required. Crockery and cutlery used for main meals are returned to the central washing-up service. The requirements of paragraphs 3.32 and 3.33 may have to be varied to accord with the Trust's catering policy.

Food trolley bay

3.34 If food is to be served from a trolley on to plates, this trolley should be located within the pantry. If plated meals on trays are delivered ready for distribution the trolley bay may be located off a circulation space.

Resuscitation trolley bay

3.35 Emergency equipment, such as the resuscitation trolley, must be parked where it is accessible from the bedrooms, but should not obstruct circulation areas.

Storage spaces

3.36 Store rooms are a costly means of providing storage as they require internal circulation space. Storage in relatively shallow cupboards or doored alcoves opening directly from circulation areas may be more convenient and cheaper. The latter is particularly useful for goods for which stocks are maintained by an exchange trolley service. If this system is adopted care must be taken in the design of the circulation spaces to ensure their minimum usable width is not restricted. A wheelchair/sani-chair bay will be required, located conveniently to the bedrooms.

Clinical store/Controlled Drugs cupboard

3.37 A back-up lockable clinical store to the clinical supplies trolleys will be required. This store will be the secure storage necessary for controlled drugs, medicines and lotions. A fridge for clinical use may be required in this area.

3.38 A red indicating lamp should be provided on each Controlled Drugs cupboard and, where appropriate, outside the doorway to the room in which the cupboard is located and at the Nurses' Station. The lamps should be interlocked with the cupboard and alarm system to give at the Nurses' Station visual and audible indication of unauthorised entry to the cupboard.

3.39 An indicating lamp denoting that the circuit is energised should also be fitted to each cupboard. The supply circuits for the lamps and alarm system should be derived from essential circuits. BS 2881 provides information on cupboards and their installation.

Large equipment store

3.40 This store is required for bulky items of equipment, bed accessories and therapy aids. Open shelving, hanging rails and hooks as well as free standing space for heavy equipment such as hoists and weighing machines is required. Disposable items delivered in bulk packages to the clinical area will require storage. Storage for beds not in use must also be allowed for unless it is provided elsewhere in the hospital.

Linen trolley bay

3.41 The type of linen store depends on the linen supply policy. This Note assumes an exchange trolley system which requires space to park linen trolleys. The volume of space is determined by the frequency of delivery.

Clinical supplies trolleys

3.42 Clean and sterile goods for daily use may be held on trolleys, at the point of use in the bedrooms under worktops, as determined by the Trust's policy for the storage of clinical supplies.

Administration areas

Reception

3.43 A reception may be required in larger units. It should be in a prominent position at the entrance. The counter needs to be stepped so that a person in a wheelchair can see and speak easily to the receptionist. The desk requires sufficient working space for a receptionist and one other who will welcome patients, relatives and staff, and undertake the local clerical and administrative duties.

3.44 The reception desk will be linked by computer to all areas. Space is required for a computer terminal and associated equipment. It should be wired as the centre for the patient to staff and a staff call system within the area. It should incorporate a facility for transferring a staff to staff emergency call to another manned point.

Office meeting room

3.45 This office is a multi-purpose office, but is likely to be used principally by clinical and therapy staff to complete notes on discharged patients, undertake telephone calls and for staff discussions. It should be sized to accommodate a desk with a computer terminal, a table and up to four people.

Charge nurse/Sister's office

3.46 An office is required from which to organise the work of the ward. This includes writing notes, interviewing staff and planning and recording patient care. The office should be adjacent to the Nurses' Station and General Office/Meeting Room. At least one IT point will be required.

Nurses' Station

3.47 The Nurses' Station is the base at which nurses may receive, read or give instructions and record information in the nursing records held there. It acts as the observation point for bedrooms, especially at night. If a computer terminal is to be provided, the privacy of records and noise implications should be considered and appropriate measures taken. The Nurses' Station should be located near the utilities.

Stationery store/IT room

3.48 A general stationery store room, where a printer may be kept, may be required. It should be shelved and well lit. The IT node cabinet could also be located in this room.

Day space/waiting area

3.49 A seated area should be provided near the reception desk for patients, relatives and ward visitors waiting to be received. The area may also serve as additional informal day space for patients. A public telephone should be located in this area.

Staff lockers

3.50 Staff will require local change facilities to leave outdoor clothes and secure lockers to hold small personal belongings easily accessible while on duty. The staff lockers should be located adjacent to the Type 3 Staff shower/wash-hand basin (Optional accommodation). It is assumed that central changing accommodation will be available for non-resident staff.

Utilities

Utility/sluice/test room

3.51 The room serves as the temporary storage point and testing area for specimens. Bulky items such as bedpans with their carriers are stored here, as is equipment for the destruction of disposable, etc. Such equipment may generate significant noise levels and care should be taken to eliminate this. Colour-coded disposal bags for the bagging of waste materials should be kept here.

Domestic services/cleaners room

3.52 The domestic services/cleaners room is the base from which domestic service staff provide the immediate day-to-day cleaning service. A clinical wash-hand basin should be provided. It should include storage for cleaning materials and equipment in daily use and facilities for the routine servicing and cleaning of equipment. The room should be well lit and ventilated so that equipment can dry quickly; mechanical ventilation may be required. Bulky equipment has to be moved in and out of the room and this should be taken into account in its location. Cleaning materials should be stored in a secure cupboard.

3.53 Space should be sufficient for the storage, washing, drying and manoeuvring of cleaning machines; for loading, parking and unloading trolleys, and for emptying and filling buckets and bowls. Access to the sink should be unrestricted.

Disposal hold/bay

3.54 The disposal room is the temporary storage point for all items of supplies and equipment that have to be removed for cleaning, reprocessing or destruction, e.g. linen and sterile services department items.

3.55 The waste disposal of used items should be consistent with the current hospital policy for the disposal of clinical waste. The bay may have to be divided into separate clean and dirty areas.

Switchgear cupboard

3.56 A departmental switchcupboard housing the main isolators and distribution fuse switchgear should be:

- accessible directly from the circulation area (access space may be part of the circulation area);
- sited away from water services;
- lockable.

3.57 Where possible the cupboard should be sited within the department. There should be clear and safe access for maintenance staff and care should be taken to ensure that safety is not compromised, during maintenance, from passing traffic or the opening of adjacent doors.

Essential complementary accommodation (ECA)

Seminar room

3.58 It is assumed that a designated education centre with conference facilities for multi-disciplinary use will be available on site. If this is not the case, accommodation for teaching, tutorials, etc should be provided in accordance with the Trust's policy (see also paragraph 4.52).

Staff rest room/beverage bay

3.59 Rest room facilities are required where staff can relax and take beverages. Rest rooms should have windows and a pleasant outlook and be comfortably furnished.

3.60 The rest room should include a beverage bay with facilities for preparing beverages for staff, for washing and storing crockery and cutlery, for storing a limited quantity of dry goods, and for the refrigerated storage of milk, etc.

3.61 Equipment should include a stainless steel sink and drainer, a refrigerator, an electric water boiler, and a worktop with cupboards.

Assisted bathroom (Type 2)

3.62 One assisted bathroom should be provided for approximately 24 patients. Patients using an assisted bathroom may arrive in a wheelchair or on a mobile hoist. Staff assist the patient in bathing and associated activities, and may also give treatments. A variable height peninsular bath is essential. Space must be sufficient to accommodate three staff, and permit the manoeuvring of support equipment such as a hoist. The room should also contain a WC, wash-hand basin and possibly a bidet.

Optional accommodation (OA)

Bathroom (Type 1)

3.63 A standard bathroom must be provided if no baths are located in en suite facilities. The bathroom would be for the use of fully ambulant, semi-ambulant and independent wheelchair patients. The bathroom should include a WC and a wash basin and should generally be designed in accordance with Section 6.5 of ‘Common Activity Spaces’ HBN 40 Volume 2: ‘Treatment areas’ 4 and HBN/SHPN 40 Volume 5: Scottish Appendix.

Staff shower (Type 3)

3.64 This shower is for fully ambulant staff only and should generally be designed in accordance with Section 6.10 of ‘Common Activity Spaces’ HBN 40 Volume 3: ‘Staff areas’ and HBN/SHPN 40 Volume 5: Scottish Appendix.

Cook/chill trolley holding room

3.65 Adjacent wards share this optional space.

3.66 To this space a number of purpose built trolleys are delivered from the Central Food Production Unit and await transfer to the ward at mealtimes. The space must be large enough to permit the easy manoeuvre of the large heavy trolleys. For further information see HBN 10 ‘Catering department’.

Dedicated day room

3.67 As discussed in paragraph 3.31, a dedicated day room can be a useful multi-purpose room that can be used to contain more disturbing activities such as watching TV or smoking but can also function as a holding area for patients waiting to go home or for other staff or patient activities when space is not available elsewhere. The quality of environment should be similar to that described in paragraph 3.30.

Medical staff office

3.68 Doctors with in-patient responsibilities require office accommodation (at least one office for 24 beds) for administrative and clerical work in connection with their clinical responsibilities and for study, research and discussions with colleagues.

4. General functional and design requirements

Introduction

4.1 This Chapter contains guidance concerning aspects of function and design which are common to health buildings generally and which will need to be borne in mind when designing new buildings or upgrading existing premises. Certain aspects which have particular relevance to wards are discussed in greater detail.

Economy

4.2 The planning of hospital buildings requires design solutions that not only satisfy functional requirements but also ensure maximum economy in respect of both capital and running costs. Due weight must therefore be given to the questions of space provision, maintenance (including cleaning), energy consumption and staffing requirements. Planning should ensure that spaces are used as intensively as possible and are not unnecessarily duplicated. Wherever possible spaces should be designed for flexibility of function, not only in their original use but also in terms of future change of use.

Alterations and extensions to existing buildings

4.3 Guidance for new build is not intended to apply retrospectively to alterations to buildings. Nevertheless, the principles are equally valid and they should be applied wherever practicable when buildings are altered* or extended. Applying the Building Standards (Scotland) Regulations to this type of work sometimes presents difficulties. The basic principle is that the Regulations apply to both alterations and extensions but not to unaffected parts of the building even if these parts do not conform to the Regulations.

4.4 The cost of alterations and/or extensions should be established in accordance with the guidance outlined in the Healthcare Construction Project Price Guide published by NHS in Scotland Property and Environment Forum Executive. The guidance takes into consideration the estimated life of an existing building and the difference in cost between works to an existing building and that of new building.

4.5 Before any decision is made to carry out such a project an option appraisal should be undertaken as described in the Healthcare Construction Project Price Guide. Consideration must be given to the long-term strategy for the

* Alterations include upgradings and adaptations of existing buildings.

service, the space required for the new service and the size of the building. Regard must also be paid to the orientation and aspect of the building and the adequacy and location of all necessary support services.

4.6 If there emerges a prima facie case for upgrading, a thorough analysis of all functional and physical conditions of the existing building should be undertaken.

4.7 When comparing alteration and/or extension of existing buildings with new build, economic considerations will not be the only criteria to be considered. Due account should be taken of matters such as location, accessibility, staffing, etc. The check of physical and other aspects of existing buildings should include:

- availability of space for alterations and additions;
- type of construction;
- insulation;
- age of the buildings, condition of fabric for example external and internal walls, floors, roofs, doors and windows, which can be determined by a condition survey;
- life expectancy and adequacy of engineering services, ease of access and facility for installation of new wiring and pipework, if required;
- the heights of ceilings (high ceilings do not necessarily call for the installation of false ceilings which are costly and often impair natural ventilation);
- changes of floor levels to obviate hazards to disabled people;
- fire precautions;
- physical constraints to adaptation such as load bearing walls and columns.

4.8 Having decided that existing premises are suitable for upgrading or conversion, the main requirement will be to assess how best the accommodation can be planned so as to facilitate the practice of modern care.

4.9 This summary of the main aspects of upgrading is general in character and it is recognised that each upgrading project will present its own problems. In many instances compromises may have to be made between Planning Note standards and what it is possible to achieve. Alterations should be functionally sound not merely cosmetic - and appropriate for the projected needs of patients and staff for a number of years to come. Extensions should be regarded as new build wherever practicable.

Statutory and other requirements

4.10 NHS Circular No 1991 (GEN)1 issued in January 1991 advised Health Boards of the requirement to comply with all relevant legislation following the removal of Crown immunity under Section 60 of the NHS and Community Care Act 1990. Health Boards and NHS Trusts are reminded of their responsibility for ensuring compliance with all statutes, regulations, codes and standards.

Smoking

4.11 Following NHS Management Executive letter MEL(1992)24 issued 30 July 1992, which set a target date of 31 May 1993, all health boards and NHS Trusts have introduced and implemented written no-smoking policies. No smoking is now the standard in all NHS premises. Although the policies may allow for provision for designated smoking areas for staff and patients, increasingly, boards and Trusts are adopting a total restriction on smoking. MEL(1992)24 refers to a fuller set of guidance available for those boards and Trusts who might find it a helpful resource. This guidance includes a statement that consideration should be given on how to adequately ventilate smoking rooms.

Fire safety

4.12 The project team members should familiarise themselves with NHS in Scotland Firecode which contains technical guidance on fire safety in hospitals and other National Health Service premises.

4.13 It is important to establish during the design stage those aspects of fire safety strategy which affect the design, configuration and structure of a ward. At appropriate stages of the design process the architect and engineer will be required to discuss their proposals with the local fire brigade, and ensure that the project team and all other NHS staff are fully acquainted with the fire safety strategy for the design in operational terms (staff responsibilities, etc) equipment provision, and engineering layouts. Health Technical Memoranda 57, 58, 59, 60 and ‘Wayfinding’ give detailed information on the selection of fire resisting components and fire signs.

4.14 The principles of fire safety apply to both new projects and to alterations and upgrading of existing buildings.

Telephones

4.15 Central telephone facilities for internal and external calls should be extended to serve the ward in accordance with the requirements shown on the Activity Data Sheets. Wiring should terminate at each extension point in a standard line jack unit. When telephones are fitted with an audible bell or buzzer this should be fitted with a muting facility for night-time operation. All telephones should be fitted with visual indicators.

4.16 Outlets should be provided for fixed payphones for the use of staff and visitors only. Payphones for use by visitors should be located near to the visitors' accommodation and the waiting area, and should be fitted with an inductive coupler to assist people using a hearing aid. Guidance concerning the provision of telephone services, including the telephone internal cabling distribution and telephone handsets, is given in HBN 48 -' Telephone services'. Refer also to paragraphs 5.80 to 5.83.

Security/control of access

4.17 Assaults on hospital staff and theft of NHS property are recognised problems. The project team should discuss security with the officer in charge of the local Police Crime Prevention Department and the hospital or district security officer or adviser at an early stage in the design of the building. Fire and Security Officers should be consulted concurrently because the demands of security and fire safety may sometimes conflict. The attention of planners is drawn to circular NHS No 1984 (Gen)7 and the updated NHS Security Manual issued with Management Executive Letter MEL(1992)35 on 21 July 1992.

4.18 Security needs to be considered from both the point of view of security from outside intruders and the safety and security of patients and staff. The building should be designed, fitted and equipped to a standard which reduces the risk of injury to users. The creation of a homely, domestic environment will be of equal importance. Refer also to paragraphs 5.74 to 5.76.

Valuables

4.19 Facilities should be provided for the temporary security of patients' valuables in a staff office. Valuables requiring longer-term storage should be kept in accordance with the hospital operational policy.

Drugs

4.20 Secure storage for Controlled Drugs will be required. Because of their potential for abuse, normal control procedures over all drugs may need to be strengthened. Refer also to paragraphs 5.62 to 5.64.

Damage in health buildings

4.21 When designing and equipping health buildings, the likely occurrence and effects of accidental damage should be considered. Damage in health buildings has increased over the years, to some extent as a result of lightweight, often less robust, building materials. Measures to minimise damage should be taken in the form of protective corners, buffers and plates where necessary, and to proper continuation of floor surfacing, i.e. strong screeds and fully bonded floor coverings. Protective devices, if used, should be capable of being renewed as need arises and should be designed as part of the decoration to retain the relaxed domestic character.

Building Component data

4.22 The Building Component Database consists of a series of Health Technical Memoranda (HTMs), 54–71 which provide specification and design guidance on building components for health buildings which are not adequately covered by current British Standards. No firms or products are listed. The numbers and titles of the various SHTMs and HTMs in the series are listed in ‘References’.

Environmental considerations

4.23 The effect of operations and actions on the environment is of significant importance and is an integral part of the responsibility for the health and well-being of the community. Care must be taken to contain the environmental impact of activities to a practical minimum consistent with maintaining responsibilities of providing high quality patient care. Commitment to the requirements of the Environmental Protection Act and all other relevant statutory legislation is essential. It is of particular importance to seek to:

- continue to promote the efficient use of energy in an economical and environmentally sound manner by promoting energy conservation and where economically viable, investing in energy saving technology and management;
- provide environmental training to appropriate staff, ensure that all staff are aware of the environmental policy and how they can contribute to the overall environmental performance;

- promote waste minimisation and reduce the environmental impact of waste through beneficial use, where practicable, or safe disposal where not;
- reduce, where practicable, pollution to air, land and water.

Internal environmental conditions

Noise and sound attenuation

4.24 In order for the environment to be relaxing and non-institutional in character, the building will have to cater for both noisy and quiet activities and this should be borne in mind during the early stages of planning. It is important that quiet areas are not adjacent to noisy areas. Utility rooms and pantries likely to be used at night should not be too close to bedrooms.

4.25 In addition to appropriate planning measures, noise can be lessened by isolating sound sources with sound containing partitions and doors, by attenuating sound with acoustic materials and generally using soft floor coverings, curtains and other such materials. There will be a need to ensure oral privacy, i.e. that confidential conversation is unintelligible in adjoining rooms or spaces. This will be typically required in consulting/examination rooms and interview/discussion rooms.

Floors

4.26 It is important to select a floor covering which contributes towards the creation of an attractive environment, but one which does not present a hazard to disabled people or the movement of wheeled equipment.

4.27 Carpets are suitable for use in the offices, staff rest room, overnight stay accommodation and visitors' waiting areas. For further information on soft floor coverings, see HTM 61.

4.28 It is also important that whatever floor covering is chosen it can be effectively cleaned, maintained and repaired. Rapid developments in soft floor covering technology have produced a wide variety of new materials. (See Health Technical Memorandum 61 - 'Flooring'.) Floors should not present or appear to present a slip hazard and the patterning should not induce disorientation. Surface drag, static electricity, flammability and infection hazards are other factors which need to be considered - see also 'Maintenance and Cleaning' – paragraph 4.48.

Doors and frames

4.29 Doors should be wide enough to allow easy passage. Lever handles should be 900mm above the floor level. Rails across the sight-line of seated people should be avoided in the design of glazed doors. If magnetic door closers are required to meet fire regulations, they should be carefully selected to minimise interference with day-to-day activities. Any locked fire exit doors must have the capability of release on the activation of the fire alarm or a local release facility of a type not likely to tempt patients to misuse it.

Ventilation

4.30 Natural ventilation is usually caused by the effect of wind pressure. It will also occur to some extent if there is a temperature difference between inside and outside the building. This thermo-convective effect frequently predominates when the wind speed is low and will be enhanced if there is a difference in height between inlet and outlet openings. Ventilation induced by wind pressure can promote high air change rates through a building if air is able to move freely within the space from windward to the leeward side of the building.

4.31 Internal partitions, fire compartment walls and closed doorways can, however, often impede the flow path and when this happens the process will be more dependent on single-sided ventilation. Nevertheless, even with this degree of obstruction to air movement, acceptable ventilation may still be obtained without excessive window openings which could prejudice safety, security and comfort. Some types of windows, e.g. vertical sliding, can enhance single - sided air exchange by temperature difference and these will improve the overall rate of natural ventilation in protected or sheltered areas where the effect of wind pressure is likely to be minimal. Section 2.3 of HTM 55 and BS 5925 provide further guidance on this subject.

Heating

4.32 Space heating should be designed for continuous operation and should be available during the summer months for use on cold days and nights. Heat emitters should be free of sharp edges and should be easy to clean. Emitters should not create an obstruction and should not be located behind beds. Exposed hot water pipework, accessible to touch, should be insulated.

Furnishings and finishes

4.33 Designers should aim to create an interior which is comfortable and pleasant to look at. The choice of fittings and furniture should form an integral part of the design process and should be co-ordinated within the overall design scheme. Finishes should be functional and be compatible with the need for comfort, cleanliness and safety. The quality of finishes should, in general, conform with the standard of finishes specified for the rest of the hospital.

Cleaning regimes should be considered when materials are selected. For further information see HTM 87 – 'Textiles and furniture'.

Natural and artificial lighting

4.34 The design of windows must reconcile different needs as well as providing natural daylight and outside views. In addition to the various statutory requirements, the following aspects also require consideration:

- illumination and ventilation;
- insulation against noise;
- thermal loss or solar gain;
- the prevention of glare;
- the provision of a visual link with the outside world.

4.35 Design should ensure that it is possible for cleaners to have easy access to the inside and outside of windows. Guidance on types of window and on the safety aspects is available in HTM 55 - 'Windows'.

4.36 Where windows are located in the wall behind the bedheads, it is necessary to ensure that the space requirements for beds, lockers, bedhead services, etc are not compromised to the disadvantage of either patients or staff.

4.37 Décor should be light and pleasant. Natural lighting is essential to the well-being of patients. The provision of a comprehensive artificial lighting installation is also essential; it makes an important contribution to the aesthetic appeal of the ward. It should be possible to vary the level of illumination to suit functional activities. Task lighting of the required intensity with low-contrast glare-free background illumination should be provided. All lighting in the ward should have suitable colour rendering characteristics.

4.38 Orientation is an important consideration in any site development scheme. Sunlight enhances colour and shape and helps to make a room bright and cheerful. Glare can be reduced by attention to the detail of window design, and can be controlled by curtains or blinds. The harmful effects of undesired solar gain can be mitigated by external screens – a costly solution – or by architectural detail of the shape of windows and depth of reveals. Properly controlled solar gain contributes to energy efficiency.

Internal rooms

4.39 Internal rooms may contribute to economy in planning but the resulting continuous need for artificial lighting and mechanical ventilation will add to both capital and running costs. Such rooms do not provide good working conditions hence should be used only for activities of infrequent or intermittent occurrence or which demand a controlled environment. Rooms that are likely to be occupied for any length of time by staff or patients should have windows.

Art in hospitals

4.40 Works of art and craft can make a significant contribution towards the desired standard of the interior of wards and day hospitals. This need not be limited to the conventional hanging of pictures on a wall. Every opportunity should be taken to include works by local artists and craftspeople. These may include paintings, murals, prints, photographs, sculptures, decorative tiles, ceramics and textile hangings.

4.41 Often it is works of art and craft which lend special identity and which help give a sense of locality.

4.42 Advice should be sought from experts on:

- obtaining funding;
- ensuring quality in all art and craft works;
- appropriately locating art and craft works;
- selecting artists and craftspeople.

4.43 Colour can be used to good effect for decorative and other purposes. Colour schemes can be devised to aid in the identification of particular rooms or parts of the department. Drab colours should be avoided.

People with a disability

4.44 It is essential to ensure that suitable access and facilities are provided for people who have problems of mobility or orientation or other special needs. This category includes, besides people who are wheelchair-bound, those who for any reason have difficulty in walking, those with a sensory handicap such as visual or hearing impairment, and those whose first language is not English.

Readers should refer to SHFN 14 – Disability access. Project teams are reminded of the need to comply with the provisions of:

- The Chronically Sick and Disabled Persons Act 1970 and The Chronically Sick and Disabled Persons (Scotland) Act 1972;
- The Chronically Sick and Disabled Persons (Amendment) Act 1976;
- The Disabled Persons Act 1981;
- The Disabled Persons (Services, Consultation and Representation) Act 1986;
- The Disability Discrimination Act 1995.

Attention is drawn to BS 5810: 1979 Code of Practice for Access for the Disabled to Buildings (under review). One of the effects of the 1981 Act is to apply this British Standard to premises covered by the 1970 Act, which includes those open to the public.

Wayfinding

4.45 To encourage patients and visitors to look after themselves, to use their initiative and to have freedom of movement about the unit, particular attention should be paid to wayfinding. The form of signposting used and the method of displaying notices should not detract from the desired environment but should be sufficiently explicit to be understood by patients who may be either confused or are from a different culture. Only certain doors require conventional labelling, e.g. fire exit doors, bathrooms, WCs and offices. Further guidance is available from NHS Estates publication ‘Wayfinding: Guidance for healthcare facilities’.

Waste disposal

4.46 The segregation, storage and the safe disposal of waste should comply with the guidance given in the Health and Safety Commission - Health Service Advisory Committee 'Safe Disposal of Clinical Waste', TSO 1992, issued with letter reference NHS MEL(1993)21 and the guidance on Clinical Waste Management issued with NHS MEL(1994)88.

4.47 The waste disposal provision of used items should be consistent with the current policy of the health body for the disposal of clinical waste. A room for the temporary holding of waste should be provided at the entrance to the department.

Maintenance and cleaning

4.48 Materials and finishes should minimise maintenance and be compatible with their intended function. Building elements that require frequent redecoration or are difficult to service or clean should be avoided. Special consideration should be given to elements such as door sets, corners, partitions, and counters which may be subject to heavy use. Floor finishes should be restricted in variety and, where soft floor coverings are specified and spillage likely, should have a backing impervious to fluids and a non-absorbent pile. Wall coverings should be chosen with cleaning in mind. Advice on these topics is published in HTMs 56 - ‘Partitions’, 58 - ‘Internal doorsets’ and 61 - ‘Flooring’.

Provision for Automatic Data Processing (ADP)

4.49 Information technology has a central role in health management. The use of computers and telecommunications - and, indeed the rate of technological innovation - continues to increase. The implications for project teams are threefold: firstly, a requirement for the housing of the computers; secondly, a requirement for the provision of ducts for transmission cabling; and thirdly, sufficient space and adequate power supplies for modems, visual display terminals (VDTs) and printers, and associated software and stationery. Even if the introduction of automatic data processing (ADP) is not proposed at the time that the project team completes its brief it will be advisable to design in such a way that equipment can be introduced easily and quickly at some later date.

4.50 There are two principal matters of concern: visibility and noise. VDTs are now a familiar sight, and it will easily be appreciated that they cannot be reduced beyond a certain size. Consequently, sufficient and convenient space must be provided for them. Since the brightness of the letters displayed on the screen cannot exceed a certain limit, special attention must be given to the ambient lighting to ensure that the contents of the screen are legible. Additional space will be required in front of the screen for a keyboard. Printers are often noisy. Noise may not be too noticeable in bed areas during normal working hours but during quiet hours it will probably not be acceptable. If it is not possible to position a printer at a site remote from patient areas, expenditure on a quieter printer or on means of quietening a noisy printer can be justified.

4.51 Computer expertise is now widely available in the NHS and project teams should ensure that, at an early stage, they inform themselves concerning current and projected local computing policies, and that their proposals conform with them.

Clinical teaching and overnight accommodation

4.52 If it has been agreed that the teaching of undergraduate and postgraduate medical students will take place in the accommodation and their numbers necessitate additional space, reference should be made to the document 'Teaching Hospital Space Requirements'

5. Engineering services

Introduction

5.1 This Chapter describes the engineering services contained within the in-patient accommodation and how they integrate with the engineering systems serving a whole site. The guidance should not inhibit the design solution, but will acquaint the engineering members of the multidisciplinary design team with the design criteria and material specification needed to meet the functional requirements.

5.2 An acute hospital requires a most complex range of engineering services. These services contribute about one third of the total capital outlay and are a significant feature of an operational budget. Most of these services are required within the in-patient area. Attempts have been made in the recent past to be selective in the distribution and outlets for services in the in-patient areas in the interest of economy. This has proved a false economy – flexibility in bed utilisation is lost and the increased acuity of patient illnesses requires all bed spaces to have the full range of services.

5.3 Engineering and mechanical services have been constantly researched, studied and the findings promulgated through an extensive range of guidance – notably the Scottish Health Technical Memoranda series. This provides the specialist advice that covers the areas beyond those met in normal building and design practice. The following paragraphs summarise the relevant guidance for in-patient areas.

Model specifications

5.4 A series of model specifications including Scottish Supplements, for the specialised engineering services in healthcare buildings, has been issued nationally and is sufficiently flexible to meet local needs. The NHS in Scotland cost guidance for the engineering services in each functional unit of this accommodation is based on the qualities of material and workmanship described in the relevant parts of the model specifications.

Economy

5.5 Engineering services are a significant proportion of the capital cost and thereafter remain a continuing charge on revenue budgets. Therefore the project design engineer should ensure not only the utmost economy in initial provision, consistent with meeting the functional requirements and maintaining clinical standards, but also the optimum benefit from the total financial resources these services are likely to absorb during their lifetime.

5.6 Where various design solutions are available the consequential capital and running costs should be compared using the procedures outlined in the Scottish Capital Investment Manual.

5.7 The economic appraisal of design solutions should include heat conversion and distribution losses at the point of use. Where buildings are located remote from the development's load centre, these losses can often be significant.

5.8 The energy management and accounting system should be part of the hospital building management system (BMS) and should include metering of all services where practicable. If a hospital BMS is not available, the energy and accounting system for the unit should stand alone. It should be suitable for integration with a future BMS. Further detailed guidance is available in SHTM 2005 - ‘Building management systems’.

5.9 After satisfying the Building Standards (Scotland) Regulations (and subsequent amendments) on standards of thermal insulation, consideration should be given to the economics of additional insulation to the ground floor slab and the roof particularly, where accommodation is located in a 'low-rise' building. Where there is a solidly constructed ground floor, the inclusion of floor insulation will have the additional benefit of contributing to patient and staff comfort.

5.10 In view of the increasing costs of generating heat energy, consideration should be given to the economics of recovering some of the energy which would otherwise be discharged by mechanical ventilation systems and to turning off or reducing heating and ventilation in those spaces which are used only for part of the day.

Maximum demands

5.11 User demand on engineering services is often difficult to predict, but experience indicates that services designed for simultaneous peak conditions are seldom fully utilised in practice. The estimated maximum demand and storage requirement (where appropriate) for each engineering service in this accommodation will need to be assessed individually to take account of the range, size and shape of the functional units, geographical location, operational policies and intensity of use. The Property and Environment Forum may provide estimates of the maximum demands and storage requirements for a specific project if required by the project team.

Space for plant and services

5.12 The satisfactory performance of plant in healthcare buildings is particularly important and the building design should allow for:

- easy and safe means of access protected as far as possible from unauthorised entry;
- frequent inspection and maintenance with sufficient access panels being provided for this purpose;
- eventual removal and replacement of plant with particular attention being paid to the requirements of the Manual Handling Operations Regulations (1992) and succeeding legislation.

5.13 Recommended spatial requirements for mechanical, electrical and public health engineering services in health buildings are given in SHTM 2023 – 'Access and accommodation for engineering services'. The information in this publication is specifically intended for use during the initial planning stages when precise dimensional details of plant are not available and it makes reference to the Construction (Design and Management) Regulations.

5.14 The distribution of mechanical and electrical services to final points of use should, wherever possible, be concealed in walls and above ceilings. Heat emitters should be contained within a 200mm wide perimeter zone under window sills and critical dimensions should be taken from the boundary of this zone. The 200mm zone includes the floor area occupied by minor vertical engineering ducts and is included in the building circulation allowance.

5.15 Services contained in the space above the false ceiling, with the exception of drainage should be confined to those required for the accommodation immediately below the false ceiling. Provision of satisfactory access should be provided to pipework, fittings and valves concealed in partitions, walls and ceilings.

Activity data

5.16 Environmental and engineering technical data and equipment details are described in the Activity Data Base sheets (see Chapter 7). They should be referred to for space temperatures, lighting levels, outlets for power, telephones, equipment details, etc, and when positioning equipment and outlets. Any item that involves patient operation should be of a simple pattern and designed to inhibit interference.

Safety

5.17 The Health and Safety at Work etc Act (1974) as partly amended by the Consumer Protection Act 1987, together with the Workplace Regulations, the Work Equipment Regulations and the Construction (Design and Management) Regulations 1994 impose statutory duties on employers and designers to ensure, so far as is reasonably practical, that design and construction is such that articles and equipment will be safe and without risk to health at all times when being set, used, cleaned or maintained by a person at work. Engineering components, e.g. pipework, terminals, etc, are covered by the term 'articles' and thus these duties apply to the designers of engineering services for non-domestic buildings.

Fire safety

5.18 Fire safety measures should not only meet the requirements of the Building Standards (Scotland) Regulations and be to the satisfaction of the local fire brigade but should also conform with NHS in Scotland Firecode. Firecode gives design guidance and requirements for fire safety in healthcare buildings through a series of Scottish Health Technical Memoranda and Scottish Fire Practice Notes. Project team members should familiarise themselves with NHS in Scotland Firecode.

5.19 The design engineers should verify the design proposals are in accordance with the procedures described in paragraphs 4.12 to 4.14 of this Note.

Noise

5.20 Excessive noise and vibration from engineering services, whether generated internally or externally and transmitted to internal areas, or noise from other sources e.g. speech which can be transmitted by the ventilation system, can adversely affect the operational efficiency of the department and cause discomfort to patients and staff. However, in addition to designing for control of noise levels, there may also be a need to ensure speech privacy so that confidential conversations are unintelligible in adjoining rooms or spaces. This will be important in consulting/examination and treatment rooms, particularly where these are located adjacent to waiting areas. The noise limits and means of control advocated in SHTM 2045 – ‘Acoustics’ should provide an acceptable acoustic environment.

Control access

5.21 Devices for control and safe isolation of engineering services should be:

- located in circulation rather than working areas to avoid disruption of clinical work;
- protected against unauthorised operation, for example switchgear and fuseboards should be housed in secure cupboards and, where appropriate, water stopcocks and drain down valves should be designed/positioned to thwart deliberate flooding;
- clearly visible to and accessible where intended for operation by the department's staff;
- easily accessible and visible to commissioning and maintenance personnel.

Engineering commissioning

5.22 It is essential that engineering services should be fully commissioned and adequate test facilities and devices should be included in the design to facilitate flow measurement and regulation of all water, ventilation and gaseous services. The services should be commissioned in accordance with the methods identified in relevant Health Technical Memoranda. Engineering services for which a specific SHTM or HTM is not available should be commissioned in accordance with the following as appropriate:

- Engineering commissioning published by The Institute of Healthcare Engineering and Estate Management (IHEEM).
- Engineering Services commissioning codes published by the Chartered Institute of Building Services Engineers (CIBSE).
- Trade associations' commissioning codes.

Commissioning should also be carried out and documented in accordance with the requirements of Scottish Hospital Technical Note 1 – 'Post commissioning documentation for health buildings in Scotland'. It is essential that full information regarding commissioning codes and test methods to be used are included in the specification for engineering services.

Mechanical services

General scope

5.23 The mechanical services include the provision of heating, ventilation/air conditioning, hot and cold water services and medical gas supplies. For cost guidance purposes the distribution of all piped systems is deemed to commence at their point of entry into the accommodation and includes pipework, fittings, controls and connections to equipment and outlets. The cost guidance includes for air handling and treatment plants, ductwork and fittings, together with associated ventilation system controls.

5.24 For environmental requirements in individual spaces reference should be made to the Activity Data Base sheets. Recommended room temperatures, air change rates, hot water service temperatures, etc are grouped under 'Technical Design Data' on each A - Sheet.

Heating

5.25 General space heating requirements can usually be met by low pressure hot water radiators. They should be of the low surface temperature type and the system should be designed to ensure that the surface temperature does not exceed 43°C. Where multi finned radiators enclosed in a metal casing are used to achieve this low surface temperature, the casing should be easily accessible/removable/openable to allow rapid access for cleaning. Consideration should also be given to the use of ceiling heating as this releases space within the room. Exposed pipework, accessible to touch, serving heat emitters should be insulated in accordance with the guidance in Scottish Health Guidance Note '"Safe" hot water and surface temperatures'.

5.26 Radiators should normally be located under windows or against exposed walls with sufficient clear space between the top of the radiator and the window sill to prevent curtains reducing the output. There should be adequate space underneath to allow cleaning machinery to be used. Where a radiator is located on an external wall, back insulation should be provided to reduce the rate of heat transmission through the building fabric.

5.27 Radiators may also be used to offset building fabric heat loss in mechanically ventilated spaces. Where, for example, a number of spaces are supplied from a common ventilation system, individual room temperature control may be achieved by using thermostatically controlled radiators.

5.28 All radiators should be fitted with thermostatic radiator valves. These should be of robust construction and selected to match the temperature and pressure characteristics of the heating system. The thermostatic head, incorporating a tamper-proof facility for pre-setting the maximum room temperature, should be controlled via a sensor located integrally or remotely

as appropriate. To provide frost protection at its minimum setting, the valve should not remain closed below a fixed temperature.

5.29 Flow temperatures to heating appliances should be controlled by the BMS in accordance with space requirements and external temperatures. The system should be zoned to suit the building.

Ventilation

5.30 Single and multi-bed areas will normally be naturally ventilated, but other areas, including multi-bed areas with a depth greater than 6 metres from the external wall, may require mechanical supply and/or extract to meet clinical or functional requirements,

5.31 Wherever possible, individual spaces should be naturally ventilated in order to limit the level of mechanical ventilation. The high capital and revenue consequences of air conditioning in ward areas will rarely be justified. Cooling, however, may be required in rooms having high heat gains such as kitchens if they are located adjacent to bed areas. Cooling shall commence at 25^{o}C and shall be capable of maintaining an internal air temperature of 3^{o}C below the external air temperature.

5.32 Deep planned spaces may need mechanical ventilation. Internal planning of the ward should, therefore, seek to minimise the need for mechanical ventilation by ensuring that, wherever practicable, core areas are reserved for:

- rooms that require mechanical ventilation, for clinical or functional reasons, irrespective of whether their location is internal or peripheral, for example, sanitary facilities, preparation, disposal and sluice rooms and pantries;
- spaces which have only transient occupation and, therefore, require little or no mechanical ventilation, for example, circulation and some storage areas.

5.33 Where nursing needs and policies require a degree of physical isolation (in accordance with the Scottish Infection Manual guidance, a minimum of 4 single-bed rooms in each ward should be mechanically ventilated to meet the following requirements:

- each room should be capable of being held at a positive pressure relative to adjacent communications spaces and at a slight positive pressure relative to the room's associated sanitary facility;
- additionally, each room should also be capable of being held at a negative pressure relative to adjacent communications spaces and to that room's associated sanitary facility;
- a local control and status indication panel for these single rooms will be required showing the pressurisation status of each room and allowing

local control to alter the pressurisation of each room from positive to negative.

Where these environmental conditions are to be provided, the design engineer must ensure that a positive/negative pressure nursing environment is possible. This may be most effectively achieved by providing a separate ventilation system to satisfy the range of demands that will arise from these rooms. This arrangement will allow a flexible control regime to be adopted for other central ventilation systems in a hospital.

5.34 Air movement induced by mechanical ventilation should be from clean to dirty areas, where these can be defined. The design should allow for an adequate flow of air into any space having only mechanical extract ventilation via transfer grilles in doors or walls. Such arrangements, however, should avoid the introduction of untempered air and should not prejudice the requirements of fire safety or privacy.

5.35 Fresh air should be introduced via a low velocity system and should be tempered and filtered before being distributed via high level outlets. Diffusers and grilles should be located to achieve uniform air distribution within the space, without causing discomfort to patients and staff.

5.36 Ventilation supply plant should include air filters having a minimum arrestance of 85% when tested in accordance with BS EN 779:1993. In urban or other areas of high atmospheric pollution, a higher standard of filtration may be economically justified to reduce the level of staining to internal finishes. Filters must be readily accessible for replacement and should be provided with a pressure-differential indicator. Supply diffusers transfer and extract grilles should be chosen to facilitate easy cleaning.

5.37 A separate extract system will be required for “dirty” areas, for example, sluice and disposal and sanitary facilities. It should operate continuously throughout the day and night. A dual motor fan unit with an automatic changeover facility should be provided.

5.38 External discharge arrangements for extract systems should be protected against back pressure from adverse wind effects and should be located to avoid reintroduction of exhausted air into the building through air intakes and windows.

5.39 Further detailed guidance is contained in SHTM 2025 – ‘Ventilation in healthcare premises’.

Controls

5.40 Supply and extract ventilation systems should include controls and indicator lamps in the plant room to confirm the operational status of each system. Alarms should be repeated in the Estates department. Their selection should take account of the extent to which they can be linked to, or provided

by, a building management system serving the whole hospital. Further guidance is contained in SHTM 2005 – 'Building management systems'.

Hot, cold and drinking water services

5.41 Guidance concerning the design and installation of cold water supply pipework and distribution systems is given in SHTM 2027 – 'Hot and cold water supply, storage and mains services'. For frost protection and to prevent condensation staining decorative finishes all cold water pipework, valves and flanges should be insulated and vapour sealed. For additional information see Scottish Hospital Technical Note 2 - 'Domestic Hot and Cold Water Systems for Scottish Health Care Premises', TSO 1994.

5.42 To limit the risk of Legionnaires disease, the water services should be designed, installed and commissioned in accordance with the recommendations in Scottish Health Technical Memorandum 2040 - The Control of Legionellae in Health Care Premises - A Code of Practice, TSO, 1993.

5.43 The domestic hot water supply should be taken from the general hospital calorifier installation at a minimum outflow temperature of 60°C ± 2.5°C, and distributed to all outlets so that the return temperature at the calorifier is not less than 50°C. Outlet temperatures and fittings for sanitary equipment are shown in the Activity Data Base sheets. (See also Scottish Health Guidance Note - "Safe" hot water and surface temperatures.) The general principle being unless a higher temperature is required for functional reasons, the outlet temperature for domestic hot water should not exceed 43°C, and the water temperature at all outlets accessible to patients should not exceed 43°C or lower in certain circumstances. Thermostatic mixing valves should be of a type that has limited variation in temperature control with water pressure variation and that automatically closes the hot water supply if the cold water supply fails. The provision of one thermostatic mixing valve to serve a group of baths or showers is not acceptable. Guidance on thermostatic mixing valves is available in Scottish Health Guidance Note - '"Safe" hot water and surface temperatures'.

5.44 Where fully potable cold water systems are not provided, drinking water outlets should be provided in the preparation room and servery/pantry. The supply should be direct from the mains.

5.45 The requirements for the control of legionellae bacteria in hot and cold water systems are set out in SHTM 2040 – 'The control of legionellae in healthcare premises – a code of practice'.

Piped medical gases

5.46 Guidance on piped medical gas systems, anaesthetic gas scavenging and gas storage is contained in SHTM 2022 – 'Medical gas pipeline systems'.

Electrical services

General scope

5.47 The electrical installation includes:

- The main intake switchgear;
- Lighting;
- Power (including supplies to ventilation plant);
- Earth bonding of extraneous metal work;
- Telephone wiring;
- Wireways for data links;
- Clocks;
- Fire alarms;
- Staff location;
- Staff call.

The installation shall conform in all respects with BS 7671 – Requirements for electrical installations (current edition) and SHTM 2007 'Electrical Services – supply and distribution' and SHTM 2020 – 'Electrical safety code for low voltage systems'. Emergency electrical supplies shall be provided in accordance with SHTM 2011 – 'Emergency electrical services'.

5.48 Reference should be made to the Activity Data Base sheets for the recommended levels of internal illumination, disposition of outlets for power, telephones, call systems and clocks, etc in individual spaces.

5.49 The point of entry for the electrical supply will be a departmental switchroom housing the main isolators, the main distribution equipment and metering. The switchroom will also be the distribution centre of subsidiary electrical services and, wherever possible, all equipment should be mounted at a height to give easy access from a standing position. The switchroom should be positioned so as to minimise the cost of cabling required to serve the accommodation. All distribution boards and main switches should be contained in secure cupboards, preferably in areas where there is normally a continuous staff presence.

Electrical installation

5.50 The electrical installation in occupied areas should be concealed in screwed steel conduit and steel trunking using appropriately insulated copper conductors – see SHTM 2007. In certain circumstances however metal sheathed or steel wired armoured (SWA) cables may be used. External installations should use screwed galvanised steel conduit with waterproof fittings. Plant areas should use screwed galvanised steel conduits and galvanised steel trunking. Steel conduits and trunking wireways for

communications and data systems should also be concealed wherever possible.

Electrical interference

5.51 Care should be taken to avoid mains borne interference, electrical radio frequency and telephone interference affecting physiological monitoring equipment, computers and other electronic equipment used here and elsewhere. Guidance on the avoidance and abatement of electrical interference is contained in HTM 2014 – 'Abatement of electrical interference'. Fluorescent luminaires should comply with BS EN 55015: 1993.

5.52 Electrical products systems and installations should not cause or be unduly affected by electromagnetic interference. This requirement is in the form of an EC Directive on Electro-Magnetic Compatibility (89/336/EEC as amended by 97/263/EEC and 92/31/EEC). This Directive has been implemented in UK law by the Electromagnetic Compatibility Regulations 1992 (SI No. 2372).

Lighting

5.53 Practical methods of lighting the various functional spaces are contained in CIBSE Lighting Guide LG 02 - 'Hospital and Health Care Buildings'. The choice of luminaire should take account not only of the requirements for light distribution and visual comfort appropriate to the space, but also the operational efficiency of the light source used. Luminaires should be of a type which are easily cleaned and maintained, as well as being manufactured and tested in accordance with the requirements specified in the relevant sections of BS 4533. Generally, energy efficient luminaires should be used. Infrequently used luminaires may be fitted with compact fluorescent or incandescent lamps.

5.54 In reception and circulation areas, colour graphics and lighting should be co-ordinated to create a calm and welcoming atmosphere whilst also contributing to the safe movement of patients in the department.

5.55 It is essential that fluorescent lighting in clinical areas is derived from one of the recommended types of lamps having suitable colour rendering characteristics. In such areas the colours chosen for walls, floors and ceilings should be carefully selected. Architects and engineers should collaborate to ensure that the decorative finishes are compatible with the colour rendering properties of the lamp and that spectral distribution of the light source is not unduly altered. Consideration should be given to using the same lamp characteristics in clinical and non-clinical areas in order to simplify maintenance and stock replacement lamps.

5.56 Each bed should be illuminated by luminaires located above or behind the bedhead. Dimmer switches capable of providing appropriate illuminance at all times should control the luminaires.

5.57 Additional luminaires should be provided within the general circulation space of the multi-bed area and dimmer switches should also control these.

5.58 Local luminaires, controlled by dimmer switches, should be provided at the staff base.

5.59 Dimmer controlled localised night lighting of the Nurses' Station should provide 300 lux on the table. This will meet the needs of staff and act as a focal point for patients at night. Where visual display terminals are to be used, the lighting should be designed to avoid bright reflections on the screen and to ensure that the contents of the screen are legible and meet the Health and Safety (Display Screen Equipment) Regulations 1992 implementing EU Directive No. 90/270/EEC 1990 – Further guidance is contained in CIBSE Lighting Guide LG3. Emergency lighting should be provided on primary escape routes in accordance with SHTM 2011 – 'Emergency electrical services' and BS 5266 and should comply with the relevant sections of Firecode.

5.60 The lighting of corridors and other circulation areas, which generally are areas not covered by the Activity Data Base sheets, should be in accordance with the guidance contained in HBN 40 - 'Common activity spaces, Volume 4 – Circulation areas' and HBN/SHPN 40 Volume 5: Scottish Appendix.

5.61 Mobile examination luminaires, where provided, should operate at extra low voltage (normally fed from an in-built step-down transformer), be totally enclosed and be equipped with a heat filter. The temperature of external surfaces should be such as to avoid injury to patients and staff.

Controlled Drugs cupboard

5.62 A red indicating lamp should be provided on each Controlled Drugs cupboard and, where appropriate, outside the doorway to the room in which the cupboard is located and at a continuously staffed location. The lamps should be interlocked with the cupboard and alarm system to give visual and audible indication at the continuously staffed location of unauthorised entry to the cupboard.

5.63 An indicating lamp denoting that the circuit is energised should also be fitted to each cupboard. The supply circuits for the lamps and alarm system should be derived from essential circuits. The electrical supply to the cupboard should be via an interference proof connection unit to avoid unauthorised disconnection. The cupboards should comply with BS 2881. Further information is contained in HTM 63 – 'Fitted storage systems'. More general information is contained in 'Guidelines for the Safe and Secure Handling of Medicines' (1988).

5.64 Guidance is also contained in the Scottish Home and Health Department publication 'Guidelines for the Safe and Secure Handling of Medicines', issued with NHS Circular No. 1988 (GEN) 33.

Socket-outlets and power connections

5.65 Socket-outlets in each bed space should be supplied from at least two separately fused circuits of common phase. A total of 24 13A socket-outlets should be provided at each bed.

5.66 Sufficient 13 amp switched, shuttered socket-outlets, connected to ring or radial circuits, and should be provided to supply all portable appliances likely to be used simultaneously. The installation of twin outlets should be considered where activities occur in juxtaposition.

5.67 To enable domestic cleaning appliances, with flexible leads nine metres long, to operate over the whole of the department, switched socket-outlets should be provided in corridors and in individual rooms where considered necessary.

5.68 Appliances requiring a three-phase supply or those rated in excess of 13 amp single phase should be permanently connected to separate final subcircuits fed from the distribution board and independently switched at a local isolator of appropriate fused rating. Fixed appliances of less than 13 amp rating should be permanently connected to a double pole switched 13 amp spur outlet with indicating light and suitably fused for the appliance rating. These spur outlets may form part of a ring circuit. Isolation switches should be provided adjacent to all engineering plant and equipment for use by maintenance staff. Where appropriate provide lockable switches or separate means of disconnection.

5.69 All electrical appliances, equipment and plant items whether automatically operated or not shall be provided with indicator lamps to show when the equipment is energised. Such indicators should be incorporated in the control unit of the apparatus, in the control switch of the apparatus, in the plug top of the apparatus or in the socket outlet from which the apparatus derives its supply.

5.70 The electrical supply connections to electro-medical equipment should comply with BS EN 60601-2 1993. Advice on the power supply requirements for radiodiagnostic equipment is contained in SHTM 2007 – ‘Electrical services supply and distribution’.

Emergency electrical supplies

5.71 Guidance on emergency electrical supplies is given in SHTM 2011 – ‘Emergency electrical services’.

5.72 Socket outlets connected to essential circuits will include those at the bedheads, reception areas and any rooms where treatment may be carried out. The supplies to the controlled drugs cupboards, bedpan disposal units and refrigerators will also be derived from essential circuits.

5.73 All communication systems, alarm systems and intruder alarm systems should be supplied from essential circuits.

Door security inter-communication system

5.74 The main entrance to the in-patient accommodation should be controlled by a door security system, which may operate in conjunction with a closed circuit television system, and a verbal communication system with an electromagnetically operated door lock to be controlled from the main reception desk. Similar arrangements may be appropriate at sub-divisions of the in-patient accommodation. Lock overrides should be provided for staff use. Locks should open automatically upon the initiation of a fire alarm. Consideration should be given to the provision of an electronic/mechanical keypad door locking system. A security alarm actuating switch or button is required at the reception desk. It should be connected to a continuously occupied part of the hospital such as the telephone switchboard, the porters' room or the security room.

5.75 The requirements of Scottish Office PAN 46 Planning for crime prevention, and NAHAT Security Manual, together with supplements shall be adhered to.

5.76 If personal alarm transmitters are to be used by staff, and if they are not self contained, conduits and transmitting/receiving equipment and propagating devices such as induction loops and/or aerials will be required to suit the selected system.

Staff location system

5.77 The hospital staff location system should cover all in-patient areas.

Patient/staff call system

5.78 Call points shall be as indicated on Activity Data Base sheets and each unit will normally comprise a push button, reassurance lamp and reset switch. Visual and audible indication of operation should be provided at the Nurses' Station to give responding staff unambiguous identification of the call. The audible signal initiated by the patient should operate for one second every ten seconds until cancelled.

5.79 Further guidance is given in SHTM 2015 – 'Bedhead services'.

Telephones

5.80 The hospital telephone system should be extended to serve this unit in accordance with the requirements shown in the Activity Data Base sheets. Wiring should terminate at each extension point in a standard line jack unit. Consideration should be given, however, to a cordless telephone system that can be integrated with the staff alarm and security systems, and the staff location system. Because of the rapid developments in the communications/ security industry, project teams should evaluate the options available to them at the time of planning.

5.81 Coin and/or card operated pay phones, which may be fixed or mobile depending upon local policy, should be provided to enable visitors and patients to make phone calls (if necessary in private). Consideration should be given to providing a free phone service for taxis in public areas as appropriate. The handsets of public telephones should be provided with inductive couplers to assist people wearing hearing aids.

5.82 Self-contained intercommunication systems are relatively inflexible and limited in the extent of their economic application. Any subsequent modifications to them usually involve disproportionate cost. Only in very rare instances can such systems be justified for functional or clinical reasons. Consequently, reasons for providing a separate intercommunication system should be clearly shown. Option appraisals should be undertaken in considering the systems to be selected.

5.83 Guidance concerning the provision of telephone services, including the internal cabling distribution and telephone handsets, is contained in SHPN 48 – 'Telephone services'. Refer also to paragraphs 4.15 and 4.16.

Patient communication systems

5.84 Patients (including those with visual and auditory handicaps) may need to be kept informed of waiting times and/or called for treatments, etc. Options include announcements:

- by a member of staff personally;
- over a loudspeaker system;
- using VDTs.

Wireways for data links

5.85 Conduits and/or trunking will be required for cables to interconnect electronic equipment. The extent to which these conduits and/or trunking should link all workstations in this department and the main hospital system or elsewhere will depend on the local policy for automatic data processing. If a structured cable system is to be installed within the hospital, then the department should be provided with all outlets wired and connected. Conduits and/or

trunking may also be required to link closed-circuit television between the seminar room and treatment areas.

Wireways for physiological monitoring equipment

5.86 Since automated physiological monitoring at the bedhead may be required in the future, it may be advisable to consider installing wireways during construction. The installation of wireways after the hospital has been completed will be disruptive.

Electric clocks

5.87 Battery quartz type clocks, with sweep second hands if required, should be provided where indicated on the Activity Data Base sheets.

Radio and television

5.88 The radio/television relay system should be supplied via the hospital communal aerial installation and central amplification equipment.

5.89 Radio and TV sound should be available at each bed position with a handset having a selector switch and volume control serving an earphone unit.

5.90 TV outlet sockets should be provided in day spaces.

5.91 Details of the requirements for radio and TV are shown in the Activity DataBase. Further guidance is contained in SHTM 2015 – 'Bedhead services'.

Lightning protection

5.92 Protection of the building against lightning should be provided in accordance with SHTM 2007 – 'Electrical services supply and distribution', HSE Data Sheet DB 2 and BS 6651.

Internal drainage

General scope

5.93 The primary objective is to provide an internal drainage system which:

- uses the minimum of pipework;
- remains water- and air-tight at joints and connectors; and
- is sufficiently ventilated to retain the integrity of water seals.

Design parameters

5.94 The design should comply with the relevant British Standards and Codes of Practice, including BS 5572, BS 6367 and BS 8301 and the current building regulations. Recommendations for spatial and access requirements for public health engineering services are contained in HSE Data Sheet EA5.

5.95 The gradient of branch drains should be uniform and adequate to convey the maximum discharge to the stack without blockage. Practical considerations, such as available angles of bends, junctions and their assembly, as well as space considerations, usually limit the minimum gradient to about 1:50 (20 mm/m). For larger pipes, for example 100mm diameter, the gradient may be less, but this will require workmanship of a high standard if an adequate self-cleaning flow is to be maintained. It is not envisaged that pipes larger than 100mm diameter will be required within interfloor or ground floor systems serving this department.

5.96 Provisions for inspection, rodding and maintenance should ensure “full bore” access and are located to minimise disruption or possible contamination. Manholes should not be located within this department.

Materials specification

5.97 The materials specified for the drainage system in this department will depend upon their location and the nature of the effluent being discharged. Waste pipework should as far as practicable be concealed. Although adequate for drainage requirements, UPVC may not always be acceptable to the fire officer and should not be installed above 'sensitive' areas, e.g. operating theatres, intensive therapy, radio-diagnostic, catering departments, electrical switch-cupboards.

6. Cost information

Introduction

6.1 For all types of health buildings it is clearly of vital importance that building costs and revenue expenditure should be kept as low as possible consistent with acceptable standards. Within this general context Scottish Health Planning Notes provide a synopsis of accommodation for health buildings which the NHS in Scotland recommends for the provision of a given service.

Scottish Capital Investment Manual

6.2 The Scottish Capital Investment Manual (SCIM), published by the National Health Service in Scotland Management Executive, provides detailed guidance for each of the main stages of capital schemes including those that may ultimately be delivered using private finance. It gives practical guidance on the technical considerations of the full capital appraisal process and also provides a framework for establishing management arrangements to ensure that the benefits of every capital investment are identified, evaluated and realised. Projects will not get Scottish Executive approval unless adequate project management arrangements can be demonstrated to be in place.

6.3 The Management of Construction Projects section of the Manual provides guidance on mandatory procedures and best practice for the planning and implementation of construction projects. It covers the stages of a project from the full business case through to technical commissioning and handover. The procedures are divided into six stages:

1. full Business Case, leading to approval;
2. design;
3. tender and contract;
4. construction and equipment supply;
5. technical commissioning and handover;
6. post-completion.

Cost guidance

6.4 The Departmental Cost Guides which reflect the building and engineering requirements of new-build accommodation associated with this SHPN are promulgated by the NHS in Scotland Property and Environment Forum Executive in their annual publication Healthcare Construction Project Price Guide.

Equipment

6.5 Group 1 items are provided for in the Departmental Cost Guides associated with this SHPN. Specific guidance on Group 2 and 3 equipment is available from the Common Services Agency's Scottish Healthcare Supplies.

Equipment is categorised into four groups:

Group 1:

Items (including engineering terminal outlets) supplied and fixed within the terms of the building contract;

Group 2:

Items which have space and/or building construction and/or engineering service requirements and are fixed within the terms of the building contract but supplied under arrangements separate from the building contract;

Group 3:

As Group 2 but supplied and fixed (or placed in position) under arrangements separate from the building contract;

Group 4:

Items supplied under arrangements separate from the building contract, possibly with storage implications but otherwise having no effect on space or engineering service requirements.

Functional unit

6.6 The functional unit for this Note is the "bed unit". Six sizes of "bed units" have been costed; 16, 24, 32, 40, 48 and 56 beds, allowing the project team to choose a "bed unit" appropriate for its particular needs. The activity spaces and areas used for costing the functional units are listed in the Schedules of Accommodation at the end of this Chapter. Where a ward contains fewer or more beds than the nearest appropriate "bed unit", the costs should be adjusted to allow for the actual accommodation planned.

Essential complementary accommodation (ECA)

6.7 This comprises activity spaces which are essential to the running of a ward, but which in certain circumstances may be available in a convenient location elsewhere in the hospital. The ECA costed in this Note is listed in the Schedules of Accommodation at the end of this Chapter and detailed in Chapter 3.

Optional accommodation and services (OAS)

6.8 Where appropriate this Note draws attention to other ways of providing services or facilities, including the likely cost implications. This information will allow project teams to select the solution which is most suitable to their needs. The Optional Accommodation and Services costed in this Note are listed in the schedules and detailed in Chapter 3.

Dimensions and areas

6.9 At the early stages of a project, designers should use the brief to make an approximate assessment of the total area of accommodation involved. Schedules of areas are given at the end of this Chapter. It is emphasised that these areas are for guidance in assessing options and planning schemes only.

6.10 In determining spatial requirements, the essential factors are the critical dimensions, i.e. the minimum linear dimensions within which activities may be performed with reasonable efficiency. The area required for an activity space is the product of the critical dimensions. Reference should also be made to the ergonomic diagrams in 'Common Activity Spaces' HBN 40 Volumes 1-4 and HBN/SHPN 40 Volume 5: Scottish Appendix.

6.11 The schedules of areas were prepared for the purpose of establishing the cost guidance. It is emphasised that the areas published do not represent recommended room sizes, maximum or minimum costs, nor are they to be regarded in any way as specific individual entitlements.

Circulation space

6.12 The circulation space comprises space for all corridors, a heating and ventilation zone adjacent to external walls, small vertical ducts and spaces occupied by partitions, walls and planning flexibility. This space is included in the cost guidance.

Communications space

6.13 Staircases, lifts and plant rooms, with the exception of electrical switch cupboards, are not included in the cost guidance. The cost of communications space is covered in the 'on-costs' defined in paragraph 1.11 of Healthcare Construction Project Price Guide.

Engineering space

6.14 The cost guidance provides for space taken by mechanical and electrical service routes and for small vertical ducts. The space is included in the Schedules of Accommodation as part of the circulation provision.

Engineering services

6.15 The engineering services as described in Chapter 5, and exemplified in the Activity Data Base, are included in the cost guidance. Primary engineering services are assumed to be conveniently available at the boundary of the department but the cost guidance does include a share of the central refrigeration plant and distribution system. The cost guidance also includes for the ventilation plant and distribution system.

Mechanical services:

- Heating;
- Ventilation;
- Mechanical cooling;
- Hot and cold water (including supply and drainage for dialysis);
- Fire main;
- Medical gases.

Electrical services:

- Main intake switchgear, local isolators and distribution boards;
- Lighting;
- Power (including supplies to ventilation plant);
- Earth bonding of extraneous metal work;
- Telephone wiring (excluding handsets);
- Wireways for data links;
- Wireways for physiological monitoring equipment;
- Clocks;
- Fire and alarm systems;
- Staff/staff call systems;
- Staff location and emergency system.

Equipment Group 1:

- Controlled Drugs cupboard.

Modules

6.16 The description of the activity spaces makes it evident that a range of different organisational arrangements may be encompassed.

6.17 The principle of devolved clinical care management to the patient bedside with services and supplies located as close as possible within a cluster is enabled by the modular approach.

6.18 Clusters may be aggregated to:

- provide a greater clinical grouping, flexed use, clinical overview and variable staffing cover over the 24-hour period;
- provide shared back-up services and facilities;
- enable facilities and bed management over a group of clusters for an economy of scale.

6.19 The content of different modules and the levels of aggregation attempt to balance the conflicting demands for a clinically suitable environment, a people-centred one and for efficient use of staff and capital resources. A bed module requires to be complemented by four supplementary modules.

6.20 There is a choice of three eight-bed cluster modules which enable beds to be provided in an arrangement of 50, 75 or 100% single-bed rooms.

Module 1 is an eight-bed cluster:

- eight single-bed rooms each with an en suite facility and mini workstation;

Module 1a is an eight-bed cluster:

- four single-bed rooms each with an en suite facility and mini workstation;
- two two-bedded or one four-bedded rooms with associated en suite facilities and mini workstation;
- an assisted (type 5) WC;
- associated day space.

Module 1b is an eight-bed cluster:

- two single-bed rooms each with an en suite facility and mini workstation;
- three two-bedded rooms with associated en suite facilities and mini workstation;
- an assisted (type 5) WC;
- associated day space.

Complementary modules

Module 2 is the initial complementary module for direct patient care activities and includes:

- consultation/examination/treatment room;
- interview/sitting room;
- Nurses' Stations as required;
- resuscitation trolley bay;
- pantry;
- food trolley bay;
- wheelchair bay.

Module 3 backup storage. Storage for goods and supplies in day-to-day use will be accommodated within the workstation:

- linen trolley bay;
- clinical supplies trolley bay;
- clinical store/controlled drug cupboard;
- equipment store.

Module 4 is a utilities module including:

- utility/sluice/test room;
- small disposal/hold bay;
- domestic services/cleaner's room;
- a standard (Type 1) WC;
- switch cupboard.

Module 5 provides the essential office and administrative facilities:

- reception desk;
- general office/meeting room;
- charge nurse/sister's office;
- printer/IT/administration store room;
- waiting/social area;
- staff locker bay.

6.21 In addition, a staff rest room, a separate seminar room and an assisted bathroom (Type 2) should be provided as essential complementary accommodation. Optional accommodation includes a bathroom, staff shower (Type 3), a cook-chill holding room, resuscitation trolley bay, an office/meeting room and dedicated day room.

6.22 In this SHPN the assumption has been made that direct clinical administration will be carried out at the point of activity, at the bedside or in the consultation/examination room using a terminal linked to a local area network. Pre-admission and post-discharge correspondence, private telephone calls and small clinical team meetings may take place in the office/meeting room. However, general organisation of the work of the facility and the observation and care of patients cannot be undertaken from either a general reception desk or a shared office/meeting room. Both functions require specific spaces and a charge nurse/sister's office and Nurses' Stations have been included.

6.23 Patients likely to require treatments should, if possible**,** be accommodated in single-bed rooms both for the containment of infection and for privacy. However, if this is not possible and for patients in multi-bed rooms, the Consultation/examination room can also be used as a treatment room. It is the assumption that clinical goods and materials for use will be delivered on a daily basis to the point of use with a small back-up store.

6.24 An independent eight-bed cluster is unlikely to be required except for specialist areas.

6.25 Modules may be aggregated in a variety of ways to suit local patterns of care delivery. Once more than three bed modules are associated together some but not all support modules are replicated. The table below identifies the aggregation of modules for different bed numbers from 16 to 56 beds.

Bed unit	% Single rooms *	Module 1	Module 1a	Module 1b	Module 2	Module 3	Module 4	Module 5	Plus	Less	Total area m²
16 beds	50%	-	2	-	1	1	1	1			625
	60%	1	-	1	1	1	1	1			641
	75%	1	1	-	1	1	1	1			635
	100%	2	-	-	1	1	1	1			640
24 beds	50%	-	3	-	1	1	1	1			845
	75%	2	-	1	1	1	1	1			866
	80%	2	1	-	1	1	1	1			860
	100%	3	-	-	1	1	1	1			865
32 beds	50%	-	4	-	2	1	1	1			1136
	70%	2	1	1	1	1	1	1			1086
	75%	2	2	-	1	1	1	1			1080
	100%	4	-	-	1	1	1	1			1095
40 beds	50%	-	5	-	2	1	1	1			1355
	75%	3	1	1	2	1	1	1			1382
	80%	3	2	-	2	1	1	1			1375
	100%	5	-	-	1	1	1	1	1 resus trolley bay		1320
48 beds	50%	-	6	-	2	2	1	1			1590
	66%	3	1	2	2	2	1	1			1628
	80%	4	2	-	2	2	1	1			1620
	100%	6	-	-	1	2	1	1	1 resus trolley		1565
56 beds	50%	-	7	-	2	2	2	1	1 office meeting room	1 disposal	1860
	70%	4	1	2	2	2	2	1	1 office meeting room	1 disposal	1888
	80%	4	3	-	2	2	2	1	1 office meeting room	1 disposal	1895
	100%	7	-	-	1	2	2	1	1 office meeting room	1 disposal	1830

Aggregation of modules from 16 to 56 beds

***** Note: areas allow for family support in all single rooms**.**

Essential complementary accommodation	**Optional accommodation**
Seminar room	Bathroom
Staff rest room	Staff shower
Assisted bathroom	Cook/chill trolley holding room
	Dedicated day room
	Medical staff office

Table to show aggregation of bed and support modules and the associated area to provide facilities for up to 56 beds.

Schedules of accommodation

Planning single-bed rooms

6.26 By analysing typical examples of single-bed rooms with en suite facilities and clinical and family support areas, a mean area allowance for bed spaces in a single-bed room can be established at 21.0m^2. This value is used in generating the area modules in the schedules of accommodation.

6.27 Details of the activity spaces contained in each module follow.

Schedules of Accommodation - 8 Bed Cluster - Module 1

Activity Spaces	Space Area m²	Module 1 100% Singles No	Module 1 100% Singles Area
Bed and Sanitary Facilities			
Single Room	13.5	8	108.0
En suite assisted shower/wc/whb	4.5	8	36.0
Family and clinical support	3.0	8	24.0
Sub-Total			**168.0**
Planning		5%	8.4
Sub-Total			**176.4**
Engineering		3%	5.3
Circulation		25%	44.1
Total			**225.8**
Departmental Total			**225**
Area/bed			**28.1**

Activity Spaces	Space Area m²	Module 1a 50% Singles No	Module 1a 50% Singles Area
Bed and Sanitary Facilities			
Single Room	13.5	4	54.0
En suite assisted shower/wc/whb	4.5	6	27.0
Family and clinical support	3.0	5	15.0
Multi-bed (4 bays)	48.0	1	48.0
Day Space	20.0	1	20.0
Sub-Total			**164.0**
Planning		5%	8.2
Sub-Total			**172.2**
Engineering		3%	5.2
Circulation		25%	43.0
Total			**220.4**
Departmental Total			**220**
Area/bed			**27.5**

Activity Spaces	Space Area m²	Module 1b 25% Singles No	Area
Bed and Sanitary Facilities			
Single Room	13.5	2	27.0
En suite assisted shower/wc/whb	4.5	5	22.5
Family and clinical support	3.0	5	15.0
Multi-bed (2 bays)	28.0	3	84.0
Day Space	20.0	1	20.0
	Sub-Total		**168.5**
	Planning	5%	8.4
	Sub-Total		**176.9**
	Engineering	3%	5.3
	Circulation	25%	44.2
		Total	**226.4**
	Departmental Total		**226**
	Area/bed		**28.2**

Patient Support Facilities - Module 2

Activity Spaces	Space m²	Module 2 No	Area
Consultation/Examination/Treatment Room	16.5	1	16.5
Interview/Sitting Room	9.0	1	9.0
Nurses' Station	8.0	1	8.0
Resuscitation Trolley Bay – 1 trolley	2.0	1	2.0
Pantry/Beverage making	12.0	1	12.0
Food Trolley Bay	1.5	1	1.5
Wheelchair Bay	4.0	1	4.0
	Sub-Total		**53.0**
	Planning	5%	2.6
	Sub-Total		**55.6**
	Engineering	3%	1.7
	Circulation	25%	13.9
		Total	**71.2**

Backup Storage - Module 3

Activity Spaces	Space m²	Module 3 No	Area
Linen Trolley Bay	1.5	1	1.5
Clinical Supplies Trolley	1.5	1	1.5
Clinical Store/Controlled Drug Cupboard	1.5	1	1.5
Store – Equipment - large	10.0	0.75	7.5
	Sub-Total		**12.0**
	Planning	5%	0.6
	Sub-Total		**12.6**
	Engineering	3%	0.4
	Circulation	25%	3.1
		Total	**16.1**

Utilities - Module 4

	Space	Module 4	
Activity Spaces	**m²**	**No**	**Area**
Dirty Utility/Sluice/Test Room – small	6.5	1	6.5
Disposal hold/bay – large	8.0	1	8.0
Cleaners Room	7.0	1	7.0
WC/whb – type 1	2.0	1	2.0
Switchgear Cupboard	1.0	1	1.0

Sub-Total		**24.5**
Planning	5%	1.2
Sub-Total		**25.7**
Engineering	3%	0.8
Circulation	25%	6.4
	Total	**32.9**

Office and Administrative Services - Module 5

	Space	Module 5	
Activity Spaces	**m²**	**No**	**Area**
Reception – 2 position – open*	8.0	1	8.0
Office – 1 position + meeting area	12.0	1	12.0
Charge Nurse/Sister's Office	9.0	1	9.0
Printer/IT/administration store room*	6.0	1	6.0
Waiting Area – 5-10 persons	16.0	1	16.0
Staff locker bay	1.5	1	1.5

Sub-Total		**52.5**
Planning	5%	2.6
Sub-Total		**55.1**
Engineering	3%	1.6
Circulation	25%	13.8
	Total	**70.5**

* if required.

Essential Complementary Accommodation

	Space	Planning	Sub-Total	Engineering	Circulation	Total
Activity Spaces	**m²**	5%		3%	25%	
Staff Rest Room/Beverage Bay – 20 pers	20.0	1.00	21.0	0.6	5.3	**27.0**
Staff Rest Room/Beverage Bay – 10 pers	16.0	0.80	16.8	0.5	4.2	**21.5**
Seminar Room – 10 persons	10.0	1.00	21.0	0.6	5.3	**27.0**
Seminar Room – 20 persons	30.0	1.50	31.5	0.9	7.9	**40.5**
Seminar Room – 25 persons	45.0	2.25	47.3	1.4	11.8	**60.5**
Assisted Bathroom/wc/whb – Type 2	16.0	0.80	16.8	0.5	4.2	**21.5**

Optional Accommodation and Services

	Space	Planning	Sub-Total	Engineering	Circulation	**Total**
Activity Spaces	m²	5%		3%	25%	
Bathroom	9.0	0.45	9.5	0.3	2.4	**12.2**
Staff Shower/whb – Type 3	6.5	0.33	6.8	0.2	1.7	**8.5**
Cookchill/Hot Trolley Holding Room	26.0	1.30	27.3	0.8	6.8	**35.0**
Office/meeting room	16.0	0.80	16.8	0.5	4.2	**21.5**
Dedicated Day Room	24.0	1.20	25.2	0.8	6.3	**32.3**
Medical Staff Office	10.0	0.50	10.5	0.3	2.6	**13.4**

7. Activity data, critical dimensions and ergonomic drawings

Activity data

7.1 The Activity Data Base is a computerised information system developed by NHS Estates to help project and design teams by defining the users' needs more precisely.

7.2 The Activity Data Base is not designed for Scottish application and therefore, if used by a NHSiS Trust, should be adapted with caution.

7.3 In particular, a number of Activity Spaces in common use in Scottish Hospitals may not be included in the Activity Data Base and the individual room activities, technical data and components may well be different in a Scottish context.

7.4 Further information about the use and preparation of activity data can be obtained from:

NHS Estates,
Department of Health,
1 Trevelyan Square,
Boar Lane,
Leeds LS1 6AE.

7.5 It is unlikely that the NHS in Scotland Property and Environment Forum Executive will be publishing a Scottish version of the Activity Data Base.

Critical dimensions

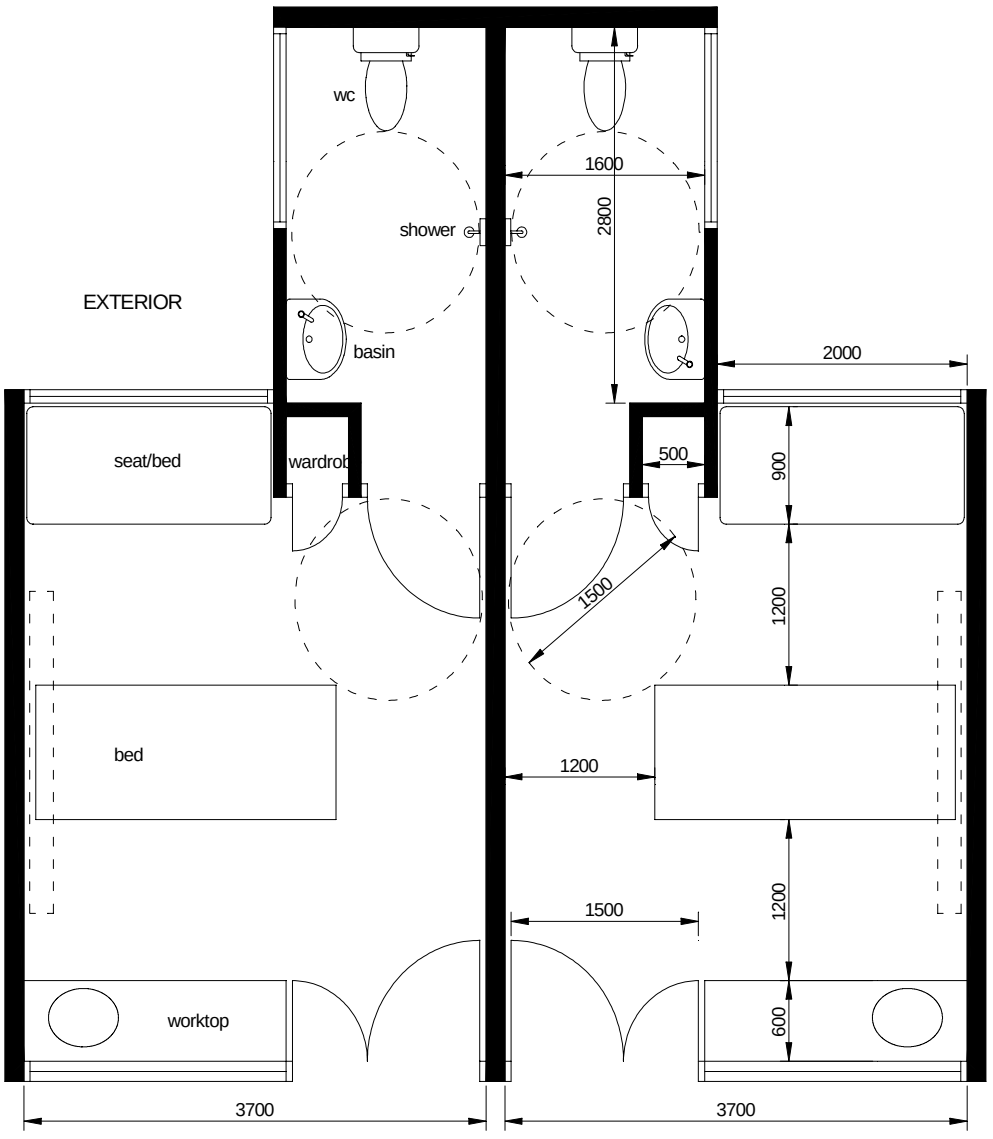
7.6 Critical dimensions are those dimensions that are critical to the efficient functioning of an activity; thus the size of components, their position and the space around them may all be critical to the task being performed. Guidance on these dimensions for a particular activity is provided in the form of ergonomic drawings**.** These illustrate components, that is equipment, furniture and fittings, and provide ergonomic data on the space required for users to move, operate or otherwise use the component; information about the component, for example fixing heights, and the users, for example reach, is also provided.

7.7 This Chapter contains ergonomic drawings relevant to this Note. In addition, ergonomic data common to the design of a number of departments is contained in NHS Estates publication 'Common Activity Spaces' HBN 40 Volumes 1-4 and HBN/SHPN 40 Volume 5: Scottish Appendix, to which reference should also be made.

7.8 List of ergonomic drawings relevant to SHPN 04

1. Single-bed room
2. Two-bed room
3. Four-bed room
4. Nurses' Station
5. Treatment room

Single-bed room



Single-bed Room

All sizes in mm

Notes:

1350 (1300)

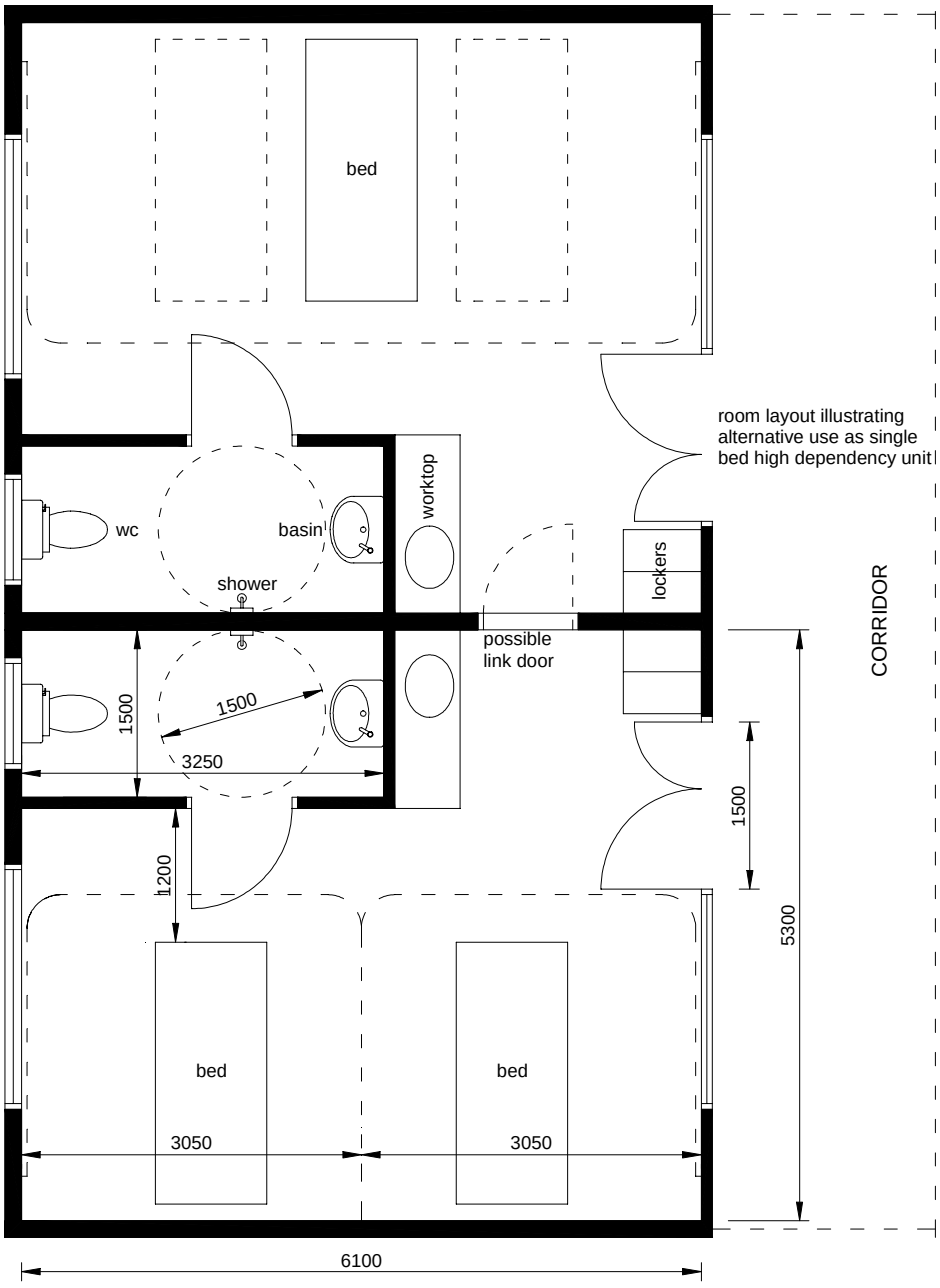
Preferred minimum: (Restricted minimum, not recommended for general use.)

Drawing not to scale

This layout shows a pair of single-bed rooms configured with external ensuite facilities. It illustrates the most efficient layout in terms of activity space, observation and circulation.

NORMAN RAITT ARCHITECTS

Two-bed room



Two-bed Room

All sizes in mm

Notes:

1350 (1300)

Preferred minimum: (Restricted minimum, not recommended for general use.)
Drawing not to scale

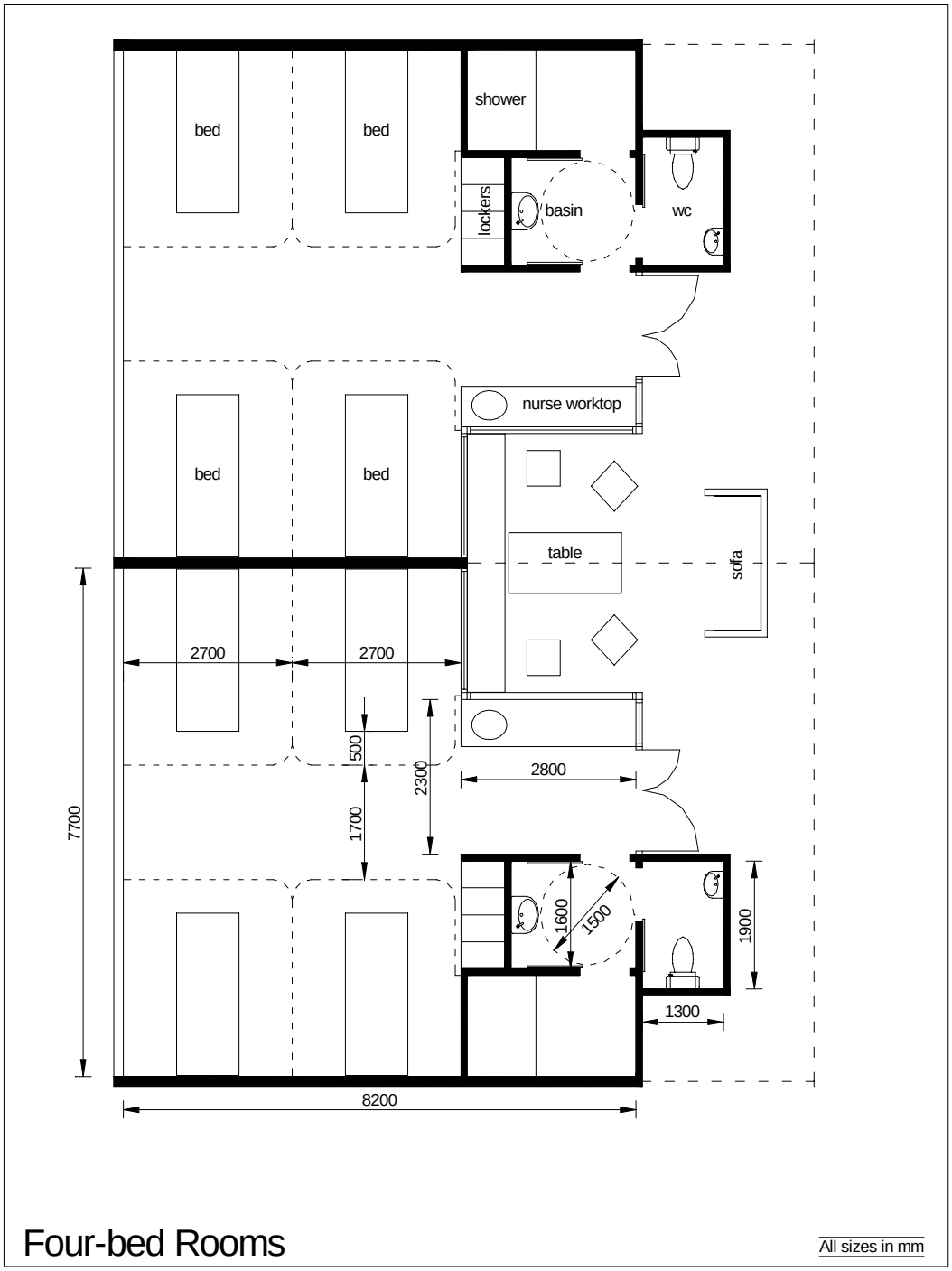
This layout shows a pair of two-bed rooms configured with ensuite facilities.
It illustrates the flexibility of room use discussed in paragraph 3.6 demonstrating alternative possible use as:

- two single-bed rooms
- two two-bed rooms
- one single-bed and one two-bed room
- one three-bed room (linked)
- one four-bed room (linked)

NORMAN RAITT ARCHITECTS

A47851278

Four-bed room



Notes:

1350 (1300)

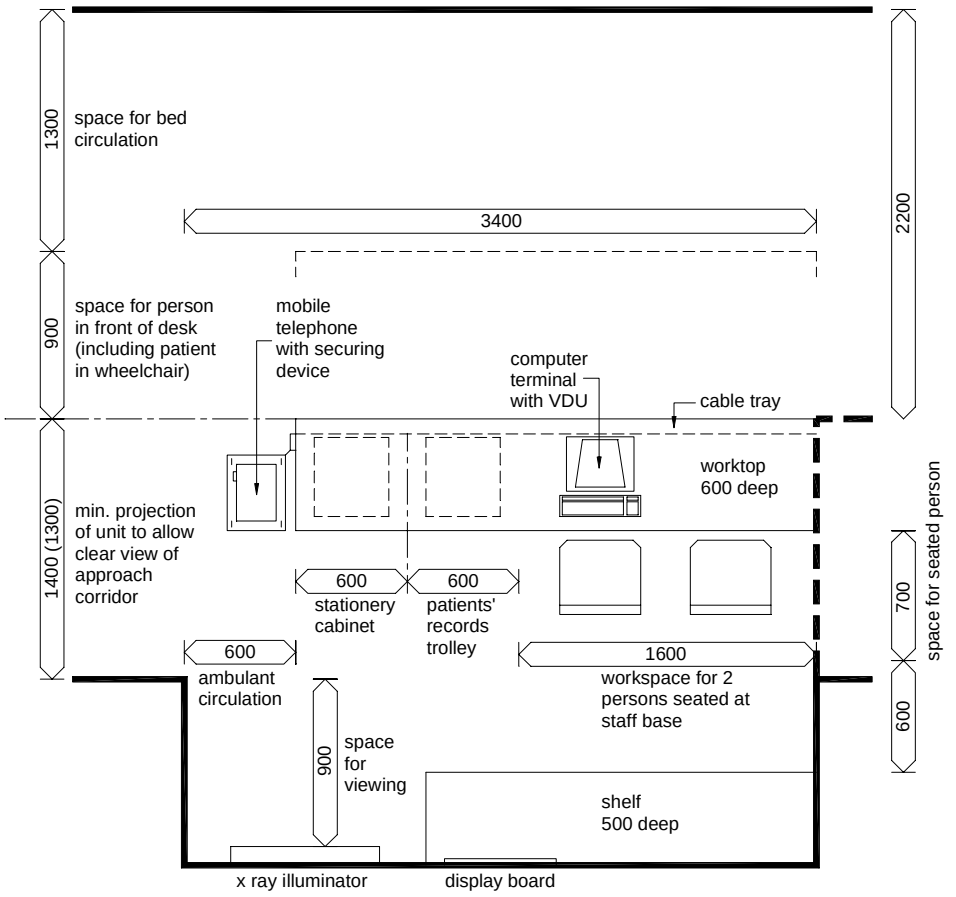
Preferred minimum: (Restricted minimum, not recommended for general use.)

Drawing not to scale

The four-bed rooms are planned with ensuite facilities to maximise views from all bed positions. Overnight stay facilities would be provided elsewhere. This arangement includes a multi-purpose day/social space integrated with the circulation and promoting more social interaction between patients, staff and visitors.

NORMAN RAITT ARCHITECTS

Nurses station



Nurses Station

All sizes in mm

Notes:

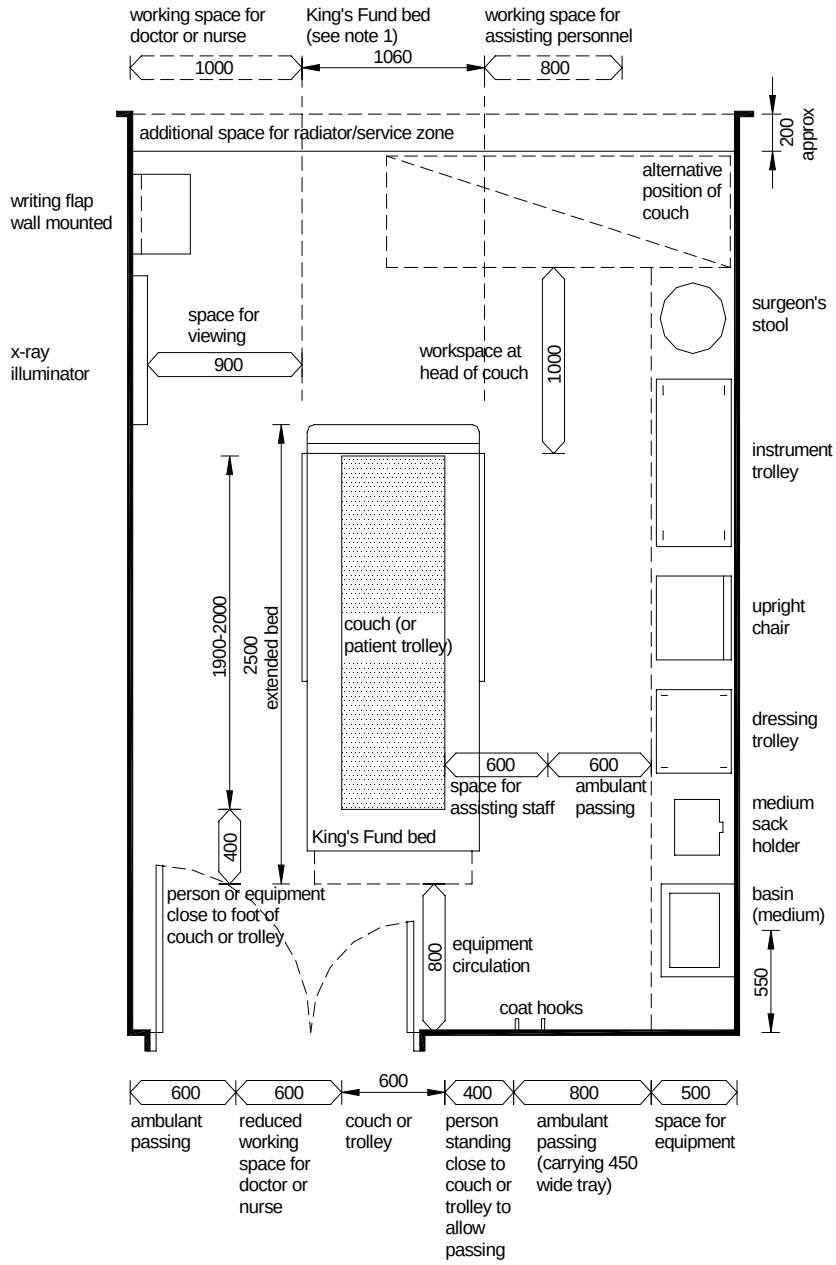
1350 (1300)

Preferred minimum: (Restricted minimum, not recommended for general use.)

Drawing not to scale

NORMAN RAITT ARCHITECTS

Treatment room: X-ray viewer



Treatment Room: X-ray viewer

All sizes in mm

Notes:

1350 (1300)

Preferred minimum: (Restricted minimum, not recommended for general use.)

Drawing not to scale

1. Treatment may be performed on a patient trolley or bed as well as on a couch When this occurs the couch must be moved to the side, away from the room centre.

2. To accommodate a King's Fund bed with orthopaedic attachments, both the room dimensions and the clear door opening should be increased.

3. When not in use, the patient couch may be situated outwith the room. In such a circumstance, the room may be of lesser dimensions.

NORMAN RAITT ARCHITECTS

Bedroom dimensions

7.9 The minimum widths of two and four-bedded rooms are 3.7m and 7.2m respectively. Single-bed rooms require, per bed, a greater length of external wall and corridor wall than do two or four-bedded rooms, so are not viewed as efficient in space terms. The minimum acceptable width is 3.4m, which allows 1.2m on either side of the bed. However, this carries the penalty of an unsatisfactory arrangement of activity zones, and the placing of the window behind the patient with limited options for locating en suite facilities.

7.10 The position of the bed influences the extent to which a patient can see out and be seen. The ability to see the daily activities within an in-patient area may provide a stimulating alternative to the views through the external window, offering the patient the opportunity to “participate” in the life of the nursing unit without needing to leave the bed. However privacy is also a factor in the planning of in-patient areas and designs need to balance these factors.

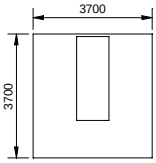
7.11 In the past in the UK room sizes have been finely tuned in relation to the proposed activities of the various spaces. A “tight” fit has been sought as a means to an overall space economy and through this an economic initial capital outlay.

7.12 Planning precisely, however, can lead to an inflexible space that cannot be used in any way other than that originally intended.

7.13 This section demonstrates the impact of different room layouts on working areas and observation and the implications of different configurations on the building envelope.

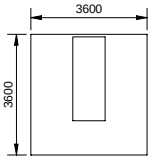
7.14 Working areas around a bed

area 12.58 sq.m.



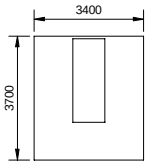
Dimensions and proportions for room with maximum bed positions

area 12.96 sq.m.

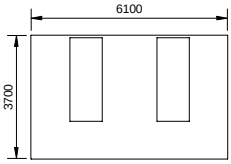


Optimum dimensions and proportions for room with bed positions commonly found in Europe

area 13.69 sq.m. Single

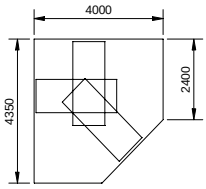


area 22.57 sq.m. Double room

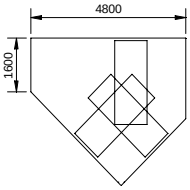


Dimensions around bed/beds with fixed orientation

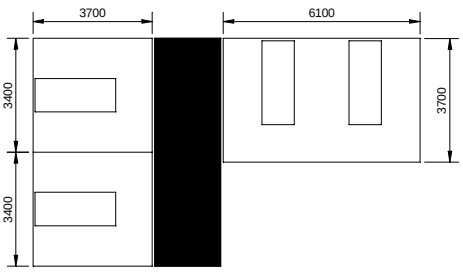
area 15.60 sq.m.

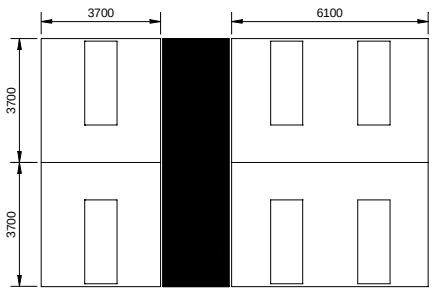


area 14.83 sq.m.



Flexibility in the position of the bed is shown above in two room shapes which meet minimum working areas. These types of room plans have been used in close packing cluster designs





En suite bathroom options for single-bed rooms

7.15 The combination and integration of en suite facilities affects not only the gross/net floor area per bed, but also the proportion of circulation, external wall area and wall-to-floor ratio, which together have a bearing on capital costs as well as operational concerns.

7.16 A comparison of bathroom options in linear arrangements of bedrooms shows the effect of bathroom location on total floor area, circulation and floor-to-wall ratios. These, together with the engineering requirements, will affect the overall building costs. The benefits are outlined for each of the illustrated layouts. (See page 87.)

7.17 Figures (a) and (d) contain the lowest floor area but include the highest proportion of circulation space.

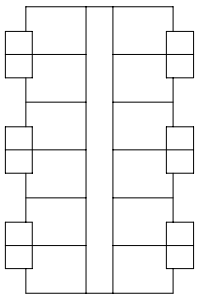
7.18 Figure (a) has the highest floor-to-wall ratio at 1:0.76, compared to (b) and (c) that have 1:0.52. Figures (b) and (c) contain the greatest floor area and (c) uses space least effectively and permits the poorest observation into the room.

7.19 Linear layouts may appear to be more economical, but are less efficient in their use of space than centric clustering arrangements.

7.20 Minimising gross floor area increases the floor-to-wall ratio and vice versa. A high floor-to-wall ratio may well be generated despite efficient and functional space planning. Economic solutions aim to optimise both the gross floor area and external wall area for any given layout.

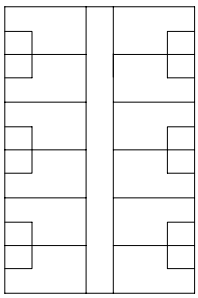
a **b** **c** **d**

En suite bathroom options for single rooms



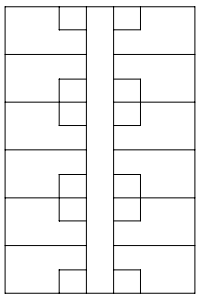
External bathroom 1

Total area = 331.0 m^2
@ 27.64 m^2 per bed
Circulation = 63.3 m^2
(inc walls and ducts @ 10 m^2)
Bedrooms = 267.7 m^2
External wall = 84.0 lin. m
% circulation = 23.0
External wall area = 252 m^2
Ration floor/wall = 1:0.76



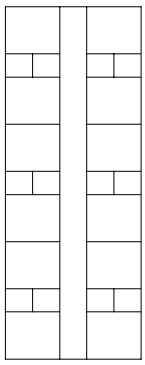
External bathroom 2

Total area = 351.0 m^2
@ 29.24 m^2 per bed
Circulation = 63.3 m^2
(inc walls and ducts @ 10 m^2)
Bedrooms = 287.7 m^2
External wall = 62.0 lin. m
% circulation = 22.0
External wall area = 186 m^2
Ratio floor/wall = 1:0.52



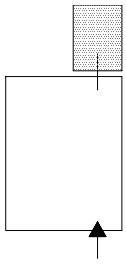
Internal bathroom

Total area = 351.0 m^2
@ 2924 m^2 per bed
Circulation = 63.3 m^2
(inc walls and ducts @ 10 m^2)
Bedrooms = 287.7 m^2
External wall = 62.0 lin. m
% circulation = 22.0
External wall area = 186 m^2
Ration floor/wall = 1:0.52



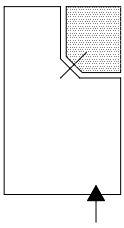
Interlocking bathroom

Total area = 330.0 m^2
@ 27.50 m^2
Circulation = 87.0 m^2
(inc walls and ducts 20 m^2) @ 10m^2)
Bedrooms = 243.0 m^2
External wall = 68.0 lin. m
% circulation = 35.0
External wall area = 204 m^2
Ration floor/wall = 1:0.61



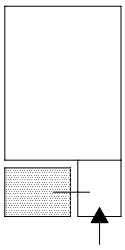
External bathroom 1
(outside envelope)

- good observation to and from room
- efficient circulation
- minimum room width
- natural light and ventilation to bathroom
- reduces window area in bedroom
- bathroom service duct could be accessed externally
- can be bolted on to an existing building



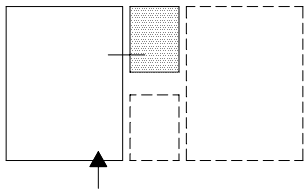
External bathroom 2
(within envelope)

- good observation to and from room
- efficient circulation
- minimum room width
- natural light and ventilation to bathroom
- reduces window area in bedroom
- bathroom service duct could be accessed externally
- increases floor area



Internal bathroom

- reduces observation to and from bedroom
- creates dead area behind doors
- increases area of unusable floor space
- maximises window area in bedroom
- bathroom service duct can be maintained from corridor



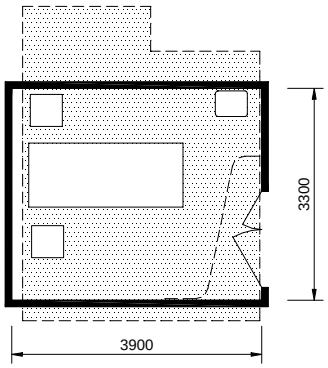
Interlocking bathrooms

- good observation to and from room
- one internal bathroom per two bedrooms
- increases overall width of room
- maximises window area in bedroom
- one service duct has to be accessed from room

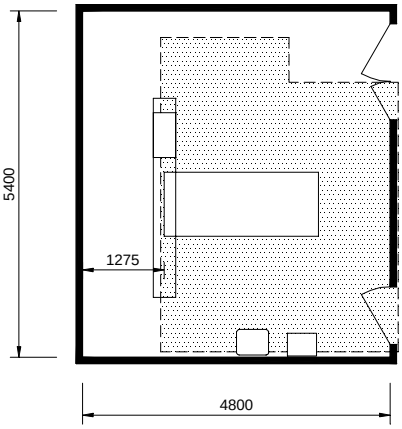
Single-bed room designs in NHS guidance

7.21 Previous planning guidance for single-bed rooms (HBN 04 1990 and HBN 40 1995) is compared to a single-bed room with en suite and integral support facilities. The single-bed room is larger to accommodate the additional bedside activity and equipment. The increase in area over HBN 04 (1990) and HBN 40 is between 32% and 50%.

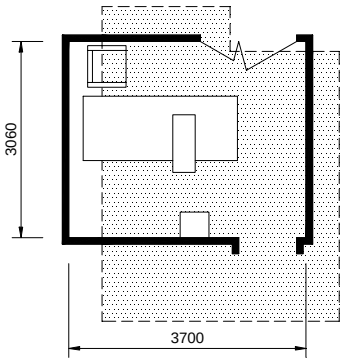
Single room
HBN 04 1990
area 12.87 sq.m.



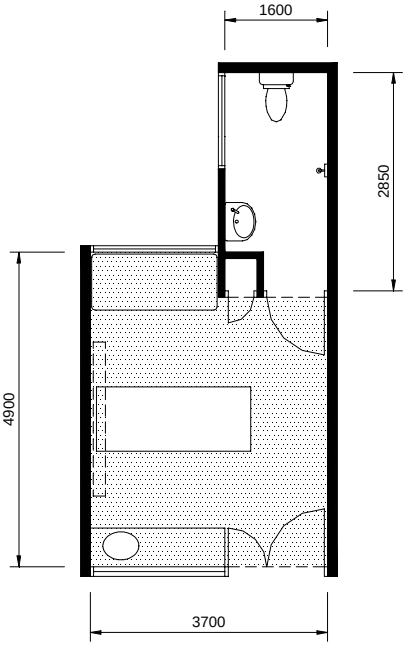
ITU/Isolation room
Nucleus data pack 1992
area 25.92 sq.m.



Single room
HBN 40 1995
area 11.32 sq.m.



Single room
HBN 04 1997
area (excl ensuite) 16.88 sq.m.



References

References are identified by paragraph number.

1.9 **NHS in Scotland Patient's Charter - Charter for Health**.

2.24 **Scottish Infection Manual**. The Scottish Office, Department of Health Public Health Policy Unit 1998.

2.25 **SI 3246: 1994 The Control of Substances Hazardous to Health Regulations (COSHH) - Guidance for the Initial Assessment in Hospitals**. TSO 1994.

2.26 **Food Safety Act 1990.** TSO 1990.

Food Hygiene Amendment Regulations 1990. TSO 1990.

2.33 **LPG aerosol containers: risks arising from storage, use and disposal**. Safety Action Bulletin SAB(88)79, Department of Health 1988.

Specification No. TSS/S 330. 1982

2.35 **Nucleus Study No. 12 'Staff Change (Options)' and Nucleus Study 13 'Decentralised-zonal staff change'**. SHHD/DS(1984)29.

3.11 **NHS in Scotland Firecode**. NHS in Scotland Property and Environment Forum Executive 1998.

3.39 **BS 2881:1989 Specifications for Cupboards for the Storage of Medicines in Healthcare Premises**. BSI 1989.

3.63 **HBN 40 – Common activity spaces, Volume 2: Treatment areas.** NHS Estates, TSO 1995.

SHPN 40 – Common Activity Spaces, Volume 5: Scottish Appendix. NHS Estates, TSO 1996.

3.64 **HBN 40 – Common activity spaces, Volume 3: Staff areas.** NHS Estates, TSO 1995.

SHPN 40 – Common Activity Spaces, Volume 5: Scottish Appendix. NHS Estates, TSO 1996.

3.66 **HBN 10 – Catering Department**. NHS Estates, TSO 1997.

4.3 **SI 2179:1990(S187) The Building Standards (Scotland) Regulations (with subsequent amendments)**. TSO 1990.

4.4 **Healthcare Construction Project Price Guide**. NHS in Scotland Property and Environment Forum Executive (annual publication).

4.5 **Healthcare Construction Project Price Guide**. NHS in Scotland Property and Environment Forum Executive (annual publication).

4.10 **Removal of Crown immunity under Section 60 of the NHS and Community Care Act 1990**. NHS Circular No 1991(GEN) 1 January 1991.

4.11 The Scottish Office NHS in Scotland Management Executive letter MEL(1992)24, 30 July 1992.

4.12 **NHS in Scotland Firecode**. NHS in Scotland Property and Environment Forum Executive 1998.

4.13 **HTMs 57- 60**. See 4.22 below.

Wayfinding. NHS Estates 1999.

4.16 **HBN 48 – Telephone services**. NHS Estates, TSO 1997.

4.17 NHS Circular No 1984(Gen)7.

NHS Security Manual (issued with Management Executive Letter MEL(1992)35). National Association of Health Authorities and Trusts (NAHAT) 1992.

4.22 **HTM 54 – User manual**. NHS Estates, TSO 1989.

HTM 54.1 – User manual update. NHS Estates, TSO 1993.

HTM 55 – Windows. NHS Estates, TSO 1998.

HTM 56 – Partitions. NHS Estates, TSO 1998.

HTM 57 – Internal glazing. NHS Estates, TSO 1995.

HTM 58 – Internal doorsets. NHS Estates, TSO 1998.

HTM 59 – Ironmongery. NHS Estates, TSO 1998.

HTM 60 – Ceilings. NHS Estates, TSO 1989.

HTM 61 – Flooring. NHS Estates, TSO 1995.

HTM 62 – Demountable storage systems. NHS Estates, TSO 1989.

HTM 63 – Fitted storage systems. NHS Estates, TSO 1989.

HTM 64 – Sanitary assemblies. NHS Estates, TSO 1995.

HTM 66 – Cubicle curtain track. NHS Estates, TSO 1989.

HTM 67 – Laboratory fitting out systems. NHS Estates, TSO 1993.

HTM 68 – Duct panel assemblies. NHS Estates, TSO 1993.

HTM 69 – Protection. NHS Estates, TSO 1993.

HTM 70 – Fixings. NHS Estates, TSO 1993.

HTM 71 – Materials management modular storage. NHS Estates, TSO 1998.

4.23 **Environmental Protection Act**.

4.27 **HTM 61**. See 4.22 above.

4.28 **HTM 61**. See 4.22 above.

4.31 **HTM 55**. See 4.22 above.

BS 5925:1991 Code of practice for ventilation principles and designing for natural ventilation. BSI 1991.

4.33 **HTM 87 – Textiles and furniture**. NHS Estates, TSO 1993.

4.35 **HTM 55**. See 4.22 above.

4.44 **SHFN 14 - Disability access**. NHS in Scotland Property and Environment Forum Executive, 1999.

Chronically Sick and Disabled Persons Act 1970. TSO 1970.

Chronically Sick and Disabled Persons (Scotland) Act 1972. TSO 1972.

Chronically Sick and Disabled Persons (Amendment) Act 1976. TSO 1976.

Disabled Persons Act 1981. TSO 1981 (print on demand).

Disabled Persons (Services, Consultation and Representation) Act 1986. TSO 1986.

Disability Discrimination Act 1995. TSO 1995.

4.45 **Wayfinding**. NHS Estates 1999.

4.46 **Safe Disposal of Clinical Waste 1992** (issued with letter reference NHS MEL(1993)21). Health Services Advisory Committee, Health and Safety Executive 1992.

4.48 **HTMs 56, 58 and 61**. See 4.22 above.

4.52 **Teaching Hospital Space Requirements**.

5.6 **Scottish Capital Investment Manual**. The Scottish Office NHS in Scotland Management Executive, TSO.

5.8 **SHTM 2005 – Building management systems**. NHS in Scotland Property and Environment Forum Executive 1999.

5.9 **SI 2179:1990(S187) The Building Standards (Scotland) Regulations (with subsequent amendments)**. TSO 1990.

5.12 **SI 2793:1992 The Manual Handling Operations Regulations**. TSO 1992.

5.13 **SHTM 2023 – Access and accommodation for engineering services**. NHS in Scotland Property and Environment Forum Executive 1999.

SI 3140:1994 Construction (Design and Management) Regulations. TSO 1994.

5.17 **Health and Safety at Work etc Act 1974**. TSO 1974.

Consumer Protection Act 1987. TSO 1987.

SI 3004 1992 The Workplace (Health Safety and Welfare) Regulations. TSO 1992.

SI 2306: 1998 Provision and Use of Work Equipment Regulations. TSO 1998.

SI 3140: 1994 Construction (Design and Management) Regulations. TSO 1994.

5.18 **SI 2179: 1990(S187) The Building Standards (Scotland) Regulations (with subsequent amendments)**. TSO 1990.

NHS in Scotland Firecode. NHS in Scotland Property and Environment Forum Executive 1998.

5.20 **SHTM 2045 – Acoustics**. NHS in Scotland Property and Environment Forum Executive 1999.

5.22 **Engineering Commissioning**. The Institute of Healthcare Engineering and Estate Management (IHEEM).

Engineering services commissioning codes. Chartered Institute of Building Services Engineers (CIBSE).

Scottish Hospital Technical Note 1 – Post commissioning documentation for health buildings in Scotland. The Scottish Office NHS in Scotland Management Executive.

5.25 **Scottish Health Guidance Note: "Safe" hot water and surface temperatures**. NHS in Scotland Property and Environment Forum Executive 1999.

5.33 **Scottish Infection Manual**. The Scottish Office Department of Health Public Health Policy Unit 1998.

5.36 **BS EN 779:1993 Particulate air filters for general ventilation. Requirements, testing, marking**. BSI 1993.

5.39 **SHTM 2025 – Ventilation in healthcare premises**. NHS in Scotland Property and Environment Forum Executive 1999.

5.40 **SHTM 2005 – Building management systems**. NHS in Scotland Property and Environment Forum Executive 1999.

5.41 **SHTM 2027 – Hot and cold water supply, storage and mains services**. NHS in Scotland Property and Environment Forum Executive 1999.

Scottish Hospital Technical Note 2 – Domestic hot and cold water systems for Scottish healthcare premises. NHS in Scotland Property and Environment Forum Executive 1999

5.42 **SHTM 2040 – The control of Legionellae in healthcare premises – A code of practice**. NHS in Scotland Property and Environment Forum Executive 1999.

5.43 **Scottish Health Guidance Note: "Safe" hot water and surface temperatures**. NHS in Scotland Property and Environment Forum Executive 1999.

5.45 **SHTM 2040 – The control of Legionellae in healthcare premises – A code of practice**. NHS in Scotland Property and Environment Forum Executive 1999.

5.46 **SHTM 2022 – Medical gas pipeline systems**. NHS in Scotland Property and Environment Forum Executive 1999.

5.47 **BS 7671:1992 Requirements for electrical installations IEE wiring regulations (current edition with amendments)**. BSI 1992.

SHTM 2007 – Electrical services supply and distribution. NHS in Scotland Property and Environment Forum Executive 1999.

SHTM 2020 – Electrical safety code for low voltage systems. NHS in Scotland Property and Environment Forum Executive 1999.

SHTM 2011 – Emergency electrical services. NHS in Scotland Property and Environment Forum Executive 1999.

5.50 **SHTM 2007 – Electrical services supply and distribution**. NHS in Scotland Property and Environment Forum Executive 1999.

5.51 **HTM 2014 – Abatement of electrical interference**. NHS Estates, TSO 1993.

BS EN 55015: 1993

5.52 **Electro-Magnetic Compatibility (89/336/EEC)** (as amended by 91/263/EEC and 92/31/EEC) TSO 1989.

SI 2372:1992 Electro-Magnetic Compatibility Regulations. TSO 1992.

5.53 **Lighting Guide : Hospitals & Healthcare Buildings (LG2)**. Chartered Institute of Building Services Engineers (CIBSE) 1989.

5.59 **SI 2792:1992 The Health and Safety (Display Screen Equipment) Regulations**. TSO, 1992.

Lighting Guide: Hospital and healthcare premises No. LG3. Chartered Institute of Building Services Engineers (CIBSE) 1989.

SHTM 2011 – Emergency electrical services. NHS in Scotland Property and Environment Forum Executive 1999.

BS 5266:1988 Emergency Lighting. BSI 1988.

NHS in Scotland Firecode. NHS in Scotland Property and Environment Forum Executive 1998.

5.60 **HBN 40 – Common activity spaces, Volume 4: Circulation areas**. NHS Estates, TSO 1995.

SHPN 40 – Common Activity Spaces, Volume 5: Scottish Appendix. NHS Estates, TSO 1996.

5.63 **BS 2881:1989 Specifications for Cupboards for the Storage of Medicines in Healthcare Premises**. BSI 1989.

Guidelines for the Safe and Secure Handling of Medicines (issued with General Letter GEN(1988)33). Department of Health, R. Duthie TSO 1988 (out of print).

5.64 **Guidelines for the Safe and Secure Handling of Medicines** (issued with General Letter GEN(1988)33). Department of Health, R. Duthie TSO 1988 (out of print).

5.70 **SHTM 2007 – Electrical services supply and distribution** NHS in Scotland Property and Environment Forum Executive 1999.

BS EN 60601-2:1993: Medical electrical equipment particular requirements for safety. BSI 1993.

5.71 **SHTM 2011 – Emergency electrical services**. NHS in Scotland Property and Environment Forum Executive 1999.

5.75 **Planning for crime prevention (Planning Advice Note 46)**. The Scottish Office 1994.

NHS Security Manual (issued with Management Executive Letter MEL(1992)35). National Association of Health Authorities and Trusts (NAHAT) 1992.

5.79 **SHTM 2015 – Bedhead services**. NHS in Scotland Property and Environment Forum Executive 1999.

5.83 **HBN 48 – Telephone services**. NHS Estates, TSO 1997.

5.91 **SHTM 2015 – Bedhead services**. NHS in Scotland Property and Environment Forum Executive 1999.

5.92 **SHTM 2007 – Electrical services supply and distribution**. NHS in Scotland Property and Environment Forum Executive 1999.

HSE Data Sheet DB 2. Health & Safety Executive.

BS 6651:1992 Code of practice for protection of structures against lightning. BSI 1992.

5.93 **BS 5572:1978 Code of practice for sanitary pipework**. BSI 1978.

BS 6367:1983 Code of practice for drainage of roofs and paved areas. BSI 1983.

BS 8301:1985 Code of practice for building drainage. BSI 1985.

HSE Data sheet EA5. Health and Safety Executive.

6.2 **Scottish Capital Investment Manual**. The Scottish Office NHS in Scotland Management Executive, TSO.

6.4 **Healthcare Construction Project Price Guide**. NHS in Scotland Property and Environment Forum Executive (annual publication).

6.10 **HBN 40 – Common Activity Spaces, Volumes 1- 4**. NHS Estates, TSO 1995.

SHPN 40 – Common Activity Spaces, Volume 5: Scottish Appendix. NHS Estates, TSO 1996.

6.13 **Healthcare Construction Project Price Guide**. NHS in Scotland Property and Environment Forum Executive (annual publication).

7.7 **HBN 40 – Common Activity Spaces, Volumes 1- 4**. NHS Estates, TSO 1995.

SHPN 40 – Common Activity Spaces, Volume 5: Scottish Appendix. NHS Estates, TSO 1996.

7.21 **HBN 04 – Adult Acute Wards**. 1990 (out of print).

HBN 40 – Common Activity Spaces, Volumes 1-4. NHS Estates, TSO 1995.

Publications in SHPN series

Given below is a list of all Scottish Hospital Planning Notes. Those Notes which have to be read along with their counterpart Health Building Note (HBN) are marked with an *. This list is correct at time of publication of this Note, but refer also to the Health Building Notes and Scottish Health Planning Note Reference Guide published by the NHS in Scotland Property and Environment Forum Executive.

1 Health Service building in Scotland 1991 TSO

2 Hospital briefing and operational policy 1993 TSO

4 Adult acute wards (with DBS) 1992 TSO

4 Adult acute wards Supplement 1 - Activity space data sheets 1992 TSO

6 Radiology department 1995 TSO

12 Out-patients department (with DBS) 1993 TSO

12 Out-patients department Supplement A – Activity space data sheets 1993 TSO

12 Out-patients department Supplement 1 – Genito-urinary medicine clinics 1993 TSO

12 Out-patients department Supplement 2 – Oral surgery, orthodontics, restorative dentistry 1996 TSO

13 Sterile services department 1994 TSO

15 Accommodation for pathology services 1994 TSO

20 Mortuary and post-mortem rooms 1993 TSO

20 Mortuary and post-mortem rooms Supplement 1 – Activity space data sheets 1994 TSO

21 Maternity department 1996 TSO

22 Accident and emergency department in an acute general hospital 1995 TSO

22 Accident and emergency department in an acute general hospital Supplement 1 – Trauma care and minor injury 1996 TSO

26 Operating department* 1992 TSO

26 Operating department Supplement 1 – Activity space data sheets 1993 TSO

34 Estate maintenance and works operations* 1992 TSO

34 Estate maintenance and works operations Supplement I – Activity space data sheets 1993 TSO

35 Accommodation for people with acute mental illness 1994 TSO

40 Common activity spaces Volume 5 – Scottish appendix* 1996 TSO

45 External works for health buildings* 1994 TSO

47 Health records department 1995 TSO

48 Telephone services 1997 TSO

51 Accommodation at the main entrance of a District General Hospital 1992 TSO

51 Accommodation at the main entrance of a District General Hospital Supplement A – Activity space data sheets 1993 TSO

51 Accommodation at the main entrance of a District General Hospital Supplement 1 – Miscellaneous spaces in a District General Hospital 1992 TSO

51 Accommodation at the main entrance of a District General Hospital Supplement 1A – Miscellaneous spaces in a District General Hospital - Activity space data sheets 1993 TSO

Scottish Health Planning Note 54

Facilities for Cancer Care Centres

NHSScotland, P&EFEx, January 2002

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Contents

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About this series

The Scottish Health Planning Note series is intended to give advice on the briefing and design of healthcare premises in Scotland.

These Notes are prepared in consultation with representatives of NHSScotland and appropriate professional bodies. Health Planning Notes are aimed at multidisciplinary NHSScotland teams engaged in:

- designing new buildings;
- adapting or extending existing buildings.

Throughout the series, particular attention is paid to the relationship between the design of a given department and its subsequent management. Since this equation will have important implications for capital and running costs, alternative solutions are sometimes proposed. The intention is to give the reader informed guidance on which to base design decisions.

This guidance is based on core Guidance produced by NHS Estates and adapted for use in Scotland by the Property and Environment Forum Executive on behalf of the NHSScotland Property and Environment Forum.

Aims and objectives

NHSScotland's *'Our National Health: A plan for action, a plan for change'* states that in Scotland the aim is to secure the very best care for everyone, this will require a major service redesign initiative. The Scottish Executive's targets relating to driving down waiting times for screening and treatment and committed investment in new equipment, means that new and upgraded facilities for cancer care will be required. This design and briefing document provides guidance on how the built environment can be designed to support the holistic approach to cancer care.

The ultimate aim is to ensure that the physical facilities in which care is delivered enable the people who provide that care to adopt the latest techniques and best practices thereby promoting efficiency and raising service quality.

The patient's cancer journey has been used as the focus in preparing this guidance. The planning and design of the constituent parts of a cancer care centre, and the way in which those parts relate to each other, have been considered primarily with the patient in mind. In addition, the rapid development in technology – not only in patient diagnosis and treatment but also in many other aspects of care and organisation – is reflected in this document.

Finding solutions that not only advance the modernisation of cancer care but also produce environments that are genuinely sympathetic to the needs of all

users has required an innovative approach. It has been necessary to examine all aspects of cancer care: from social, clinical and scientific considerations to the detailed design and equipping of the buildings. Given such a broad approach, it is hoped that this guidance will be of interest to a wide audience.

Structure

In order to avoid excessive complexity, guidance on cancer facilities will be produced in three publications:

> 'Facilities for cancer care centres' (this document);
>
> 'Facilities for cancer care units and breast care centres' (future publication);
>
> 'Primary care and screening facilities in cancer' (future publication).

All parts will be subject to routine revision as needed. Each part builds from introductory sections describing policy, clinical and scientific background through the patient journey and associated care protocols, and uses these to inform the design process for the built environment. Schedules of accommodation will be published in a separate document covering cancer, cardiac and diagnostic imaging facilities.

Other documents relevant to facilities for cancer care

This work is constructed against a sliding scale of environment specialisation. Those rooms or areas devoted entirely to cancer services are described in detail. However, those rooms used incidentally for such care, together with common areas, are simply listed and the reader is directed to other publications as appropriate. Notable among these are HBN 15 'Accommodation for pathology services'; HBN 40 vol. 2 'Common activity spaces: treatment areas'; SHPN 26 and HBN 26 both titled 'Operating department'; and also SHPN 06 'Facilities for diagnostic imaging and interventional radiology'.

Acknowledgements

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Dr H Burns	Director of Public Health, Greater Glasgow Health Board
Dr A Gregor	Consultant Clinical Oncologist, Western General Hospital
Prof. A T Elliott	Chairman, Clinical Services Division, North Glasgow University Hospitals NHS Trust

Endorsement

"I am pleased to endorse this document produced by NHSScotland Property and Environment Forum and acknowledge the extensive work and effort put into compiling the advice herein, recognising also the core work done by our colleagues in NHS Estates, England."

Dr A Gregor, Lead Clinician for Cancer in Scotland

1. Scope of SHPN 54

Introduction

1.1 This guidance summarises the framework for the provision of cancer services and identifies the implications for the built environment in which different elements of services are delivered. It notes that the critical issue for people with cancer is that services themselves should be integrated and seamless – although these may be delivered by different healthcare institutions in various locations. The guidance describes facilities that are unique to cancer services and makes reference to features in facilities that are not used exclusively on people with cancer but have a particular relevance.

1.2 The guidance is based primarily on current government policy but is also influenced by the advice and recommendations of a number of professional and academic bodies. The intention is to present planning teams with a range of options for designing new accommodation or for adapting existing buildings.

1.3 This document is the first of three to be published. This first of the series deals primarily with the facilities and design of cancer care centres. The documents are as listed below:

‘Facilities for cancer care centres’

‘Facilities for cancer care units and breast care centres’

‘Primary care and screening facilities in cancer’.

Intended audience

1.4 This document aims to support the procurement and design of cancer care centres. The multi-disciplinary nature of modern planning teams is acknowledged and in consequence the target audience of this guidance is broader than that of some earlier counterparts.

1.5 Estates professionals will find planning and design advice herein. Background policy and basic clinical information is also given to help planning teams keep pace with rapidly developing techniques in this area.

Policy background and ‘Cancer in Scotland: Action for Change’

1.6 Policy on cancer care will be determined by the recommendations of the ‘Cancer in Scotland: Action for Change’ report, which calls for a new approach to the provision and organisation of cancer services in Scotland.

1.7 The need for a new approach arose partly from concerns about the nature of cancer. First, the incidence and prevalence of cancer for particular age groups

and body sites was, and is rising. Second, cancer places a major economic burden on both the community and the NHSScotland. In addition, it is recognised that cancer deaths could be reduced by early diagnosis through prevention and screening programmes. More recently, a growing emphasis on well-considered treatment policies and protocols has also emerged.

1.8 As well as the nature of cancer, there are also concerns about the way cancer services are being provided:

- treatment outcomes for patients are varied, due partly to variations in the organisation of local cancer services;
- patient access to services was or is unequal due to the disaggregated nature of cancer service provision;
- cancer care expertise is spread too thinly across too many geographical settings;
- the number of new patients being seen generally and in particular locations was and perhaps is too low to facilitate the development of body site specific cancer care expertise;
- co-ordination between primary/community and secondary/tertiary cancer services is inadequate;
- palliative care services for patients in the early as well as terminal stages of care need to be further developed.

Principles of the 'Action for Change' report

1.9 In response to the above challenges future cancer services should be governed by the following principles:

- wherever they may live, all patients should have access to a uniformly high quality of care in the community or hospital to ensure the maximum possible cure rates and best quality of life. Care should be provided as close to the patient's home as is compatible with high quality, safe and effective treatment;
- public and professional education to help early recognition of symptoms of cancer and the availability of national screening programmes are vital parts of any comprehensive programme for cancer care;
- patients, families and carers should be given clear information and assistance, in a form they can understand, about treatment options and outcomes available to them at all stages of treatment from diagnosis onwards;
- the development of cancer care services should be patient-centred and should take account of patients', families' and carers' views and preferences as well as those of professionals involved in cancer care. Individuals' perceptions of their needs may differ from those of the professional. Good communication between professionals and patients is especially important;

- the primary care team is a central and continuing element in cancer care for both the patient and his or her family from primary prevention, pre-symptomatic screening, initial diagnosis, through to care and follow-up or, in some cases, death and bereavement. Effective communication between sectors is imperative in achieving the best possible care;
- in recognition of the impact that screening, diagnosis and treatment of cancer has on patients, families and their carers, psychosocial aspects of cancer care should be considered at all stages;
- cancer registration and careful monitoring of treatment and outcomes are essential.

Implications of the Scottish Executive Health Department's plan for NHSScotland's built environment for cancer services

1.10 The NHS Plan 'Our National Health: A plan for action, a plan for change' was published in 1999 and has subsequently been supplemented by NHS HDL (2001) 54 and 71. Where possible, the implications of the plans have been incorporated in this document, insofar as they have an effect on cancer services. However, some of the developments listed are dependent upon the outcome of further research (called for by Government), and in consequence, the built environment implications cannot be fully assessed at the time of writing.

1.11 Essentially, the new NHSScotland plan of action prioritises cancer care as one of a number of key clinical areas to receive special attention and development. Implicit in this and explained within the Plan are expanded or new areas of expenditure covering the provision of staff, training and the enhancement of cancer care facilities in terms of buildings and the equipment which they contain. The key aim of the Scottish Executive is to improve both standards of cancer prevention and quality of care for cancer patients over a five-to ten-year period.

1.12 In summary, the expansion of cancer diagnosis and treatment facilities is a major feature of the NHSScotland Plan and implies the need for a high quality built environment and better equipment portfolios. Where possible, the drive towards these improvements has been incorporated in this guidance.

2. Cancer care centre organisation and structure

2.1 The multi-tier and multi-disciplinary approach to the care of cancer patients requires the provision of a sophisticated centre with genuinely comprehensive services. This may be devoted to either adults or children with only a few centres providing services to both groups. The cancer care centre is therefore the primary repository of both expertise and specialist facilities needed for care of patients with cancer. The relationship between cancer care facilities and the patient is demonstrated in Figure 1.

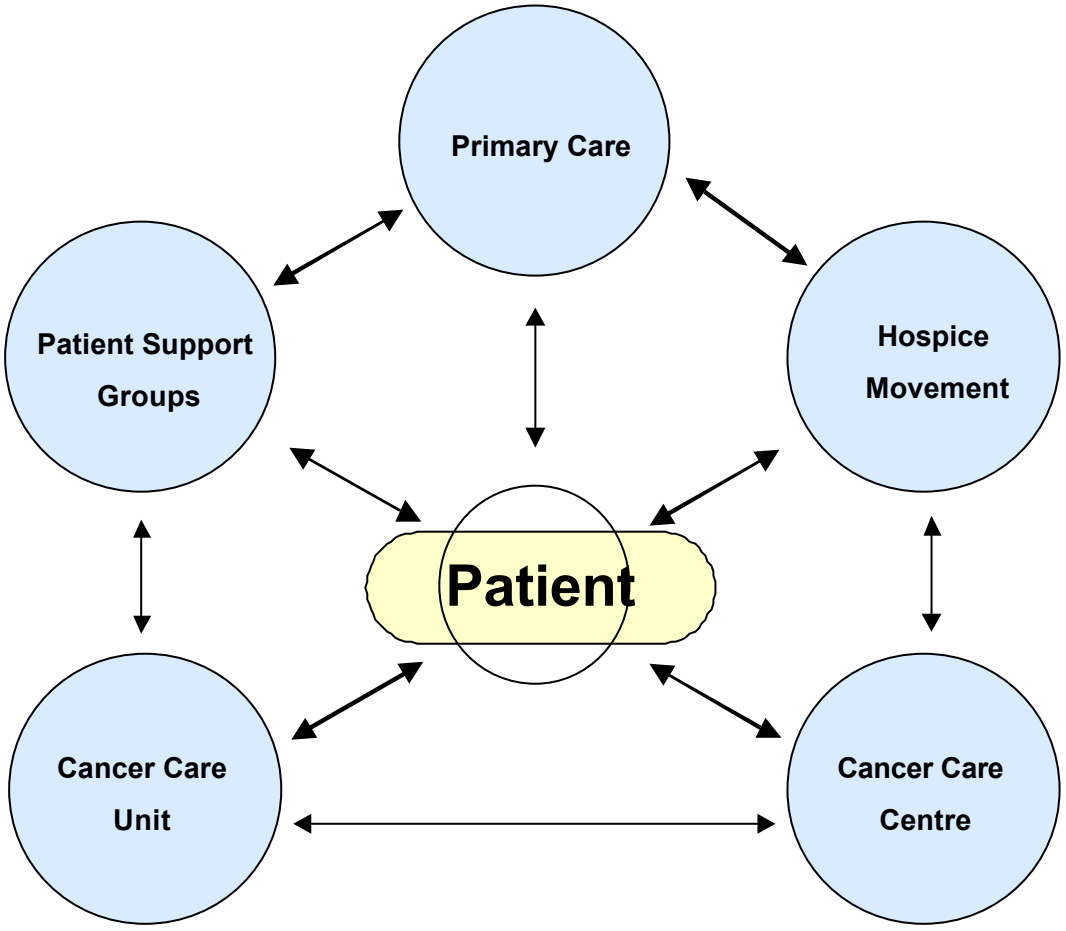


Figure 1: **Relationship between cancer care facilities and patient**

2.2 Cancer care centres operate in support of cancer units: units may refer patients to the cancer care centre for specialist diagnosis and treatment techniques. However, cancer care centres must also function as cancer units for the local catchment population. Cancer patients living locally will attend the cancer care centre rather than the cancer unit simply because it is closer to their home. Cancer care centres must therefore be fully independent offering a comprehensive range of services. A model for cancer referrals is illustrated in Figure 2.

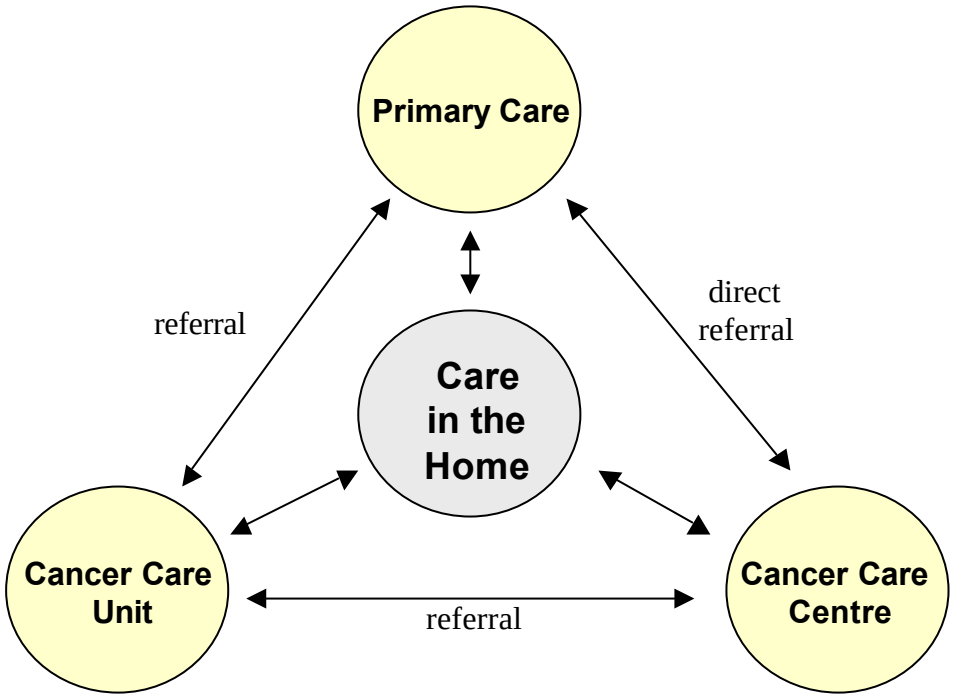


Figure 2: **Relationships between cancer care facilities: referral model**

2.3 It is envisaged that cancer care centres will be sufficiently comprehensive and multi-disciplinary as to be able to provide support to units, not only for the business of dealing with surgery and medicine/therapies concerned directly with tumours, but also in the broader care of patients and any consequential disorders which may flow from their condition. Thus, cancer care centres will support units broadly in the following ways:

- the provision of consultants for clinical sessions in surgery, medical cancer and radiation cancer;
- special pathology services closely related to cancer care such as specialist haematology and histopathology;
- the facility to transfer the patient by referral from the cancer care unit to a centre;
- provision of radiotherapy for patients otherwise cared for in a cancer unit;
- support in the process of chemotherapy regime provision;
- academic, training and research co-operation agreements;
- shared liaison with Social Services;
- development and implementation of appropriate surgical techniques.

2.4 Particular importance is attached to the surgical issues mentioned above. A move is envisaged from the use of general surgery in the treatment of cancer towards a position where cancer surgery is seen either as a speciality in its own right or as an area of trained expertise within a discipline related to particular anatomy. For example, a renal surgeon may have expertise in surgery related to cancer. There has been particular emphasis on moving breast surgery away

from the general surgical domain and into specialist centres with appropriately trained surgical staff.

Research facilities

2.5 Attention is drawn to the essential nature of research and development within the cancer community not only as a means of generating new knowledge but also for the beneficial effects on staff morale and overall service quality. For these reasons designers are asked to consider the provision of suitable and sufficient research accommodation as a basic part of each new or revised development.

2.6 Some major centres will have extensive research portfolios and facilities. These are, for the moment, beyond the scope of this guidance. However, the minimum facilities, described in the paragraphs below, will be essential to support pharmaceutical evaluations or drug trials as well as other key routine research support.

2.7 Drug trials require extensive and detailed record keeping. Accordingly, a clerical office to accommodate two to three staff will be required. This may need access to both local and wide area (LAN/WAN) computer networks. Archive space may also be a requirement, particularly in centres where clinical records are still partly paper based. These areas must be reasonably secure in order to protect the records and confidential information, which research sometimes involves.

2.8 Nurses are a key staff group for research in this area. Many centres will employ small teams of specially trained nurses to undertake or assist with research. Common (often open plan) office accommodation will be a key requirement.

2.9 Patients will often be asked to submit to additional interviews and clinical examinations when they take part in voluntary clinical trials. Many centres prefer dedicated suites to support this activity. These may be located away from other patient care areas. The minimum accommodation will consist of a number of consultation rooms with incorporated or separate examination facilities.

2.10 The majority of small research facilities will require a small laboratory for the receipt and some processing of biological materials. These rooms will be similar to those described in NHSScotland's guidance Scottish Hospital Planning Note 15:'Accommodation for pathology services', however, specifications will need to reflect local requirements and research interests. Local consultation will be essential. There are also likely to be implications for the design of facilities in associated cancer care units to be described in the second document of this guidance, 'Facilities for cancer care units and breast care centres'.

A guide to approximate sizing of cancer care centres

2.11 This is a complex issue owing to the range of diseases covered by the blanket term cancer and the similarly extensive portfolio of diagnostic, surgical and

treatment regimes, which may be applied. Accordingly, careful local evaluation will always be necessary. This will be helpful in assisting with individual evaluations in so far as service patterns and care standards are defined.

2.12 Tables 1– 4 give an outline indication of requirements for cancer care centres against the catchment area population and the numbers of new patients expected for treatment each year. The standing rate of new cancer cases per year is about 3,400 per million of population. Accordingly, simple categories of cancer care centres are derived as follows:

Category	*Catchment populations*	*New patient treatments*	*Special features*
A	450,000 – 550,000	< 1,500	Very small centre
B	550,000 – 750,000	1,500 – 2,500	Minimum full centre
C	750,000 – 1.5m	2,700 – 5,050	Regional centre
D	1.5m – 3m	5,050 – 10,000	Regional centre
E	3m – 5m	10,000 – 15,000	Regional centre

Table 1: **Catchment populations and new patient treatments**

Facility	*Category A*	*Category B*	*Category C*	*Category D*	*Category E*
Linear accelerator (ME)	1	2	2 – 5	5 – 9	9 - 15
Linear accelerator (HE)	1	2	3	3	3 - 5
Simulator/CT simulator	1 – 2	2 – 3	3 – 5	5 – 8	8 - 12
Planning workstations	1 – 2	2	3 – 4	4 – 6	6 -10

Table 2: **Radiotherapy facilities**

Facility	*Category A*	*Category B*	*Category C*	*Category D*	*Category E*
Manual overloading	Optional	1	1	1	1
LDR/MDR	Optional	1	1	2 – 3	3
HDR	-	1	1	1	1
PDR	Optional	Optional	Optional	Optional	Optional

Table 3: **Brachytherapy facilities**

Facility	*Category A*	*Category B*	*Category C*	*Category D*	*Category E*
Chemotherapy preparation	1	1 – 2	2 – 3	3 – 6	6 – 6
Full chemotherapy pharmacy	Optional	1	1	1	1
Chemotherapy treatment places – couches	12	18	25 – 45	45 – 85	85 - 135
Available operating theatres	1	1 – 2	2 – 3	3 – 6	6 - 9
Specialist operating theatres	Optional	1	1	1	2
Unsealed source treatment	-	1	1	2	2
MRI/CT	1/1 (access)	1/1 (dedicated)	1/2	2/3	3/5

Table 4: **Other major facilities**

Notes to tables 1- 4

ME – medium-energy
HE – high-energy
LDR – low dose rate
MDR – medium dose rate
HDR – high dose rate
CT – computed tomography
MRI – magnetic resonance imaging
PDR – pulsed dose rate

3. Planning considerations

Functional relationships

3.1 The constituent parts of a comprehensive cancer care centre are identified in Figure 3 below. Figure 4 then illustrates how these elements can be grouped into diagnostic, therapeutic, patient support and clinical support areas.

***Figure 3*: Cancer care centre departments**

Note: Specialist radiotherapy includes complex external beam treatments, intra-operative radiotherapy, whole body irradiation and brachytherapy.

Integrated services

3.2 It is recommended that cancer care centres be integrated with more general clinical service providers. Figure 5 illustrates which elements of the service are likely to be dedicated to the cancer care centre and which will be shared with the tertiary hospital.

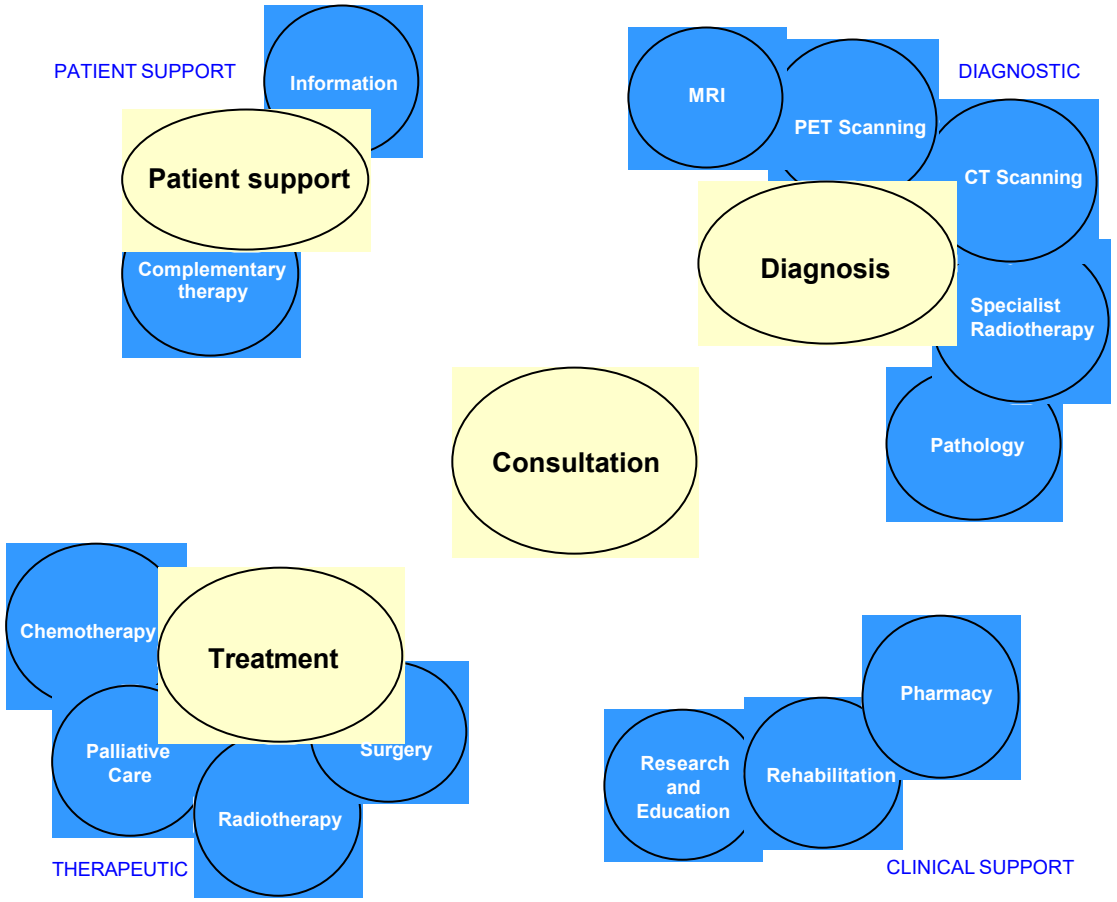


***Figure 4*: Cancer centre departmental relationships**

Siting considerations

3.3 As cancer units and centres are being unified with more general hospital provision, they are sharing services accordingly. Such integration requires a free flow of information and the broad availability of specialist expertise.

The following factors are influential when making siting decisions:

- geographical considerations related to journey times and distances anticipated for patients visiting the facility;
- access by public and private transport (use of public transport should be encouraged for the sake of the environment);

- the substantial nature of the architecture and engineering required by some cancer facilities is such that sites which favour future expansion and flexibility are preferred;
- suitability for receipt, storage, use and disposal of environmentally sensitive materials;
- relationship to academic institutions and research facilities;
- requirement for local access to non-specific but cancer-related services including surgery, pharmacy and pathology;
- the social-medical nature of cancer favours patient care on sites that are suitable for the creation of gardens and water features.

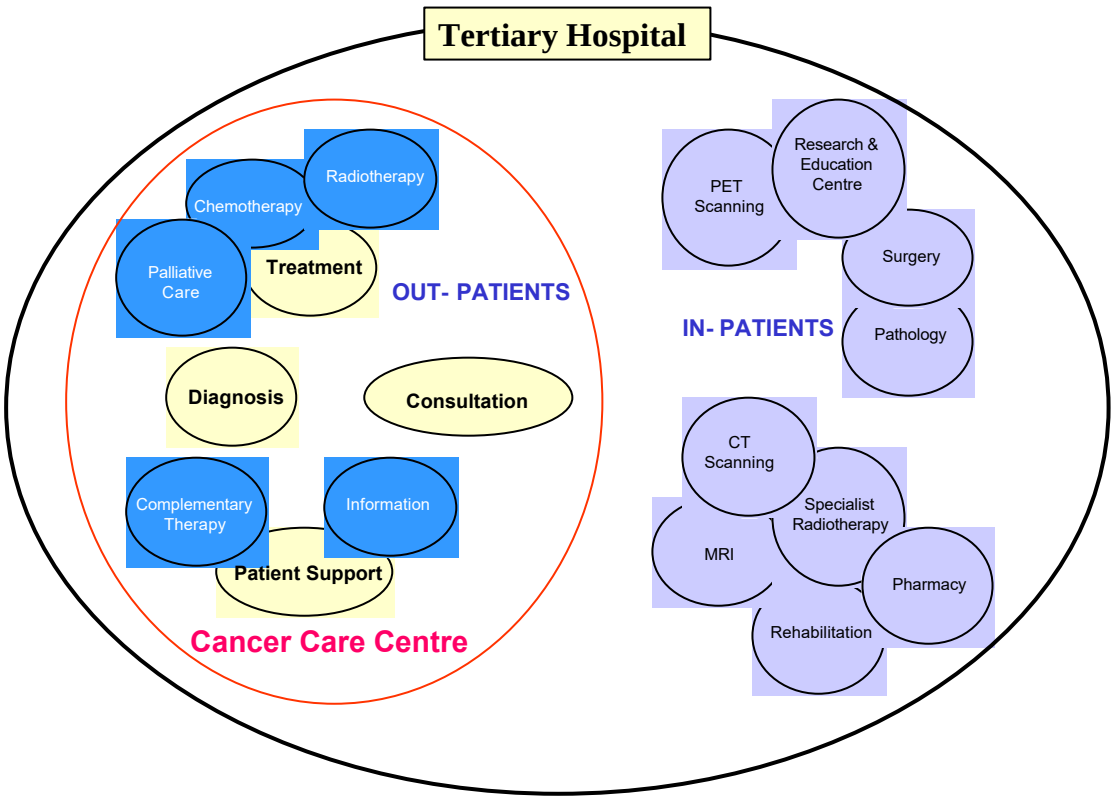


Figure 5: **Integrated general hospital cancer care centre**

4. The patient journey

Outline

4.1 For the majority of patients encountering the possibility of cancer, the initial query or suspicion of a cancer diagnosis will be made at primary care level by a general practitioner (GP). Attendance at Accident and Emergency (A&E) as an initial part of the journey is not commonly observed.

4.2 The patient will pass through the care system generally as illustrated in Figure 6, though significant variations will be observed, an outline description is provided below.

4.3 The feelings of both patients and relatives, particularly following news of a positive diagnosis, must be sensitively handled and this will reflect in the design of the built environment. So far as is possible, the facilities available should combine the need for practical efficiency with an appropriately sensitive and patient-focused quality.

Journey steps

Initial GP consultation

4.4 This may establish the suspicion of cancer or simply generate a referral arising from consideration of the patient's condition, family history and a physical examination. Some limited pathology tests using urine or blood samples may be provided. The GP surgery will typically require a quiet room, away from the remainder of the clinical area, for use in sensitive discussions with the patient and their family in support of ensuring overall as well as strictly medical care of the patient.

Hospital-based investigations

4.5 A proportion of patients will be referred direct to a purpose-built major cancer care centre offering strategic cancer services. Others will encounter a journey that involves passing through other specialist units or a local cancer unit.

Investigations

4.6 Investigations may be conducted at a cancer care unit or centre level, but the centre, with its strategic role, will be able to offer a broader and more sophisticated service.

4.7 On arrival the patient will go to a central reception area where the identity and attendance details are recorded and information on the next part of the patient's

care will be outlined. Some written explanatory information is also likely to be given. Particular care should be taken to ensure that this step is well facilitated for all patient groups including the disabled so that the patient's initial experience of the centre reflects the focus on patient care.

4.8 For the majority of patients the journey will proceed to a central or specific procedure waiting area. In a modern cancer care centre the use of schedule control systems and advanced patient management techniques will be geared to minimising waiting times. This may reflect in a smaller waiting area designed to create a reassuring environment. It is however essential that the waiting area can easily cope with peak times.

Diagnostic consultation

4.9 A meeting with a cancer specialist will outline, for the patient, the steps to be taken in moving towards achieving a reliable diagnosis and from this a plan for treatment. A consulting room will be used for this purpose and a physical examination may also be offered.

4.10 As directed, the patient will proceed to the appropriate specialist diagnostic department and report at the local reception.

4.11 The specialised tests may involve imaging, measurements, and the taking of samples of tissue and/or body fluids and are targeted at benefiting the patient by refining the diagnosis. Although these diagnostic facilities may be dominated, in design terms, by technical considerations, every effort must be made to ensure the environment is not adverse from the patient standpoint. This step may be a part of a series of differing tests involving a number of specialist facilities and journeys between these. Focus on building layout so as to simplify the journey is always necessary for the preservation of acceptable standards of care.

Treatment and diagnostic review

4.12 Where possible the cancer specialist will meet again with the patient to review progress and convey information, as this becomes available. At this point key diagnostic decisions may have been made and these will in turn give rise to discussions on treatment, prognosis or outcome for the individual patient. This news, good or bad, is likely to generate an emotional impact on those involved and this will reflect in the built environment in terms of the need to provide discrete exits and other features. For example it might be preferable for patients not to exit through the waiting areas as they may be extremely upset, and consideration may be given to providing a recovery waiting area.

4.13 The diagnostic cycle described above is likely to be repeated several times for any given patient as the disease and treatments proceed.

4.14 As Figure 6 illustrates, the patient journey now contains a complex series of options, which are dependent in terms of choice upon the patients' wishes and the availability of suitable treatments. For many patients treatment may involve

radical steps including surgery, radiotherapy and chemotherapy, though these techniques are also used in palliative care, which may have no curative intent. Psychological and Social Care may be an essential component of the journey for many patients.

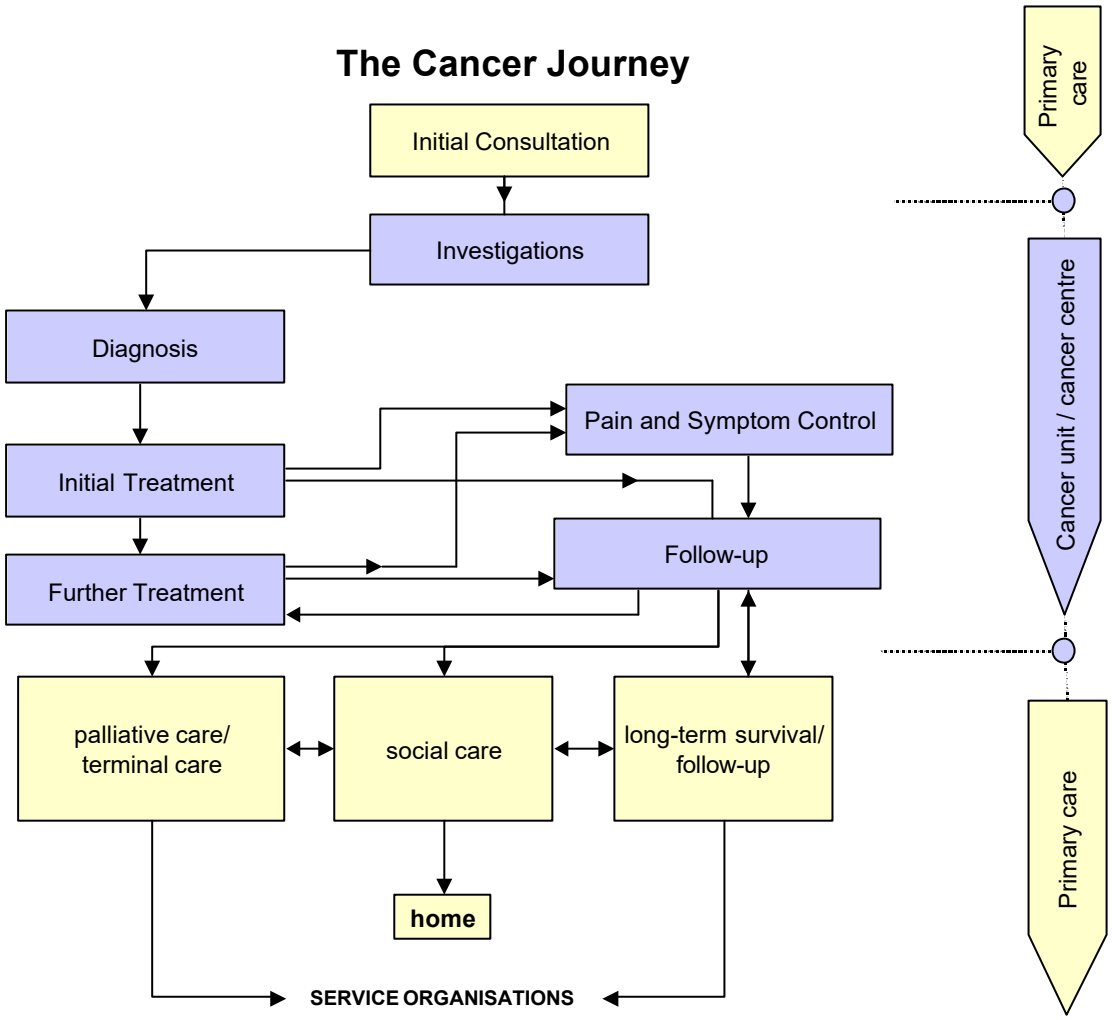


Figure 6: **Cancer care centre patient journey**

Pain and symptom control

4.15 A large proportion of cancer patients will require pain relief. Specific departments will be provided in cancer care centres with many patients making repeated visits. Both consultation and treatment rooms are required. The patient may remain within the department for several hours allowing the supervision and monitoring of treatment. The use of pain relief drugs may be supplemented by other treatments, including palliative radiotherapy.

Follow-up and monitoring

4.16 The patient will make regular visits both to his/her GP and to the cancer care centre to be apprised of progress and advised as to treatment options. These consultations will take place in general consultation rooms but again the need

for careful design to ensure respect for the patient's privacy and sensitivities is needed.

Care in the home

4.17 The cancer care centre may support care for the patient in the home by the provision of information, loan of equipment, etc. Primary care and social services will feature heavily in this part of the overall care package.

Dignity in death

4.18 For some patients the journey will regrettably end in death. In terminal illness some patients may be taken to A&E departments. Increasingly these have facilities for both patient and friends/relatives and are designed to achieve some measure of comfort and dignity in death. If a patient is admitted, a single bedded room should be provided. Others will be allowed to return home to die in the care of their GP team.

Summary of clinical procedures

Initial cancer care centre diagnostic consultation

4.19 As for all clinical episodes, the initial consultation with appropriately qualified specialists is vital. It is at this consultation that the early definitions of diagnosis will be put forward and an initial care plan devised.

Diagnostic work-up

4.20 This is a process by which the initial diagnosis is either confirmed or modified and the identity of the tumour, together with its histology or nature, is fully determined. The process is vital, as the ultimate diagnosis will determine the most appropriate care pathway.

4.21 Modern diagnostics in cancer care are multi-disciplinary and, therefore, contributions from pathology, radiology and general clinical sources need to be incorporated with a very high degree of reliability.

Tumour staging

4.22 The aim of chemotherapy, surgery or radiotherapy is to remove or at least reduce tumours. However, the success of any treatment will depend in large part on how advanced is the cancer. Accurately assessing the spread of the disease in a patient is therefore vital. In the UK there is a rigorous system for assessing the stage that the disease has reached.

Surgical planning and intervention

4.23 Much modern cancer treatment begins with a surgical intervention. The surgery requires extensive imaging before it is carried out. In common with radiotherapy, the surgeon will tend to define a target and will also wish to examine structures that must be avoided in making the surgical approach.

4.24 As an extension of the above, the use of stereotactic localisation to precisely reach tumours in the breast and cranial anatomy is well developed at some cancer care centres.

4.25 The use of image-guided minimal invasive intervention as a form of cancer treatment both in vascular and non-vascular sites is advancing rapidly and requires the provision of specialised facilities. This may replace alternative full-surgical techniques.

Treatment prescription

4.26 Whether the treatment is to be chemotherapy and/or radiotherapy, a strict prescription system is in use throughout the UK in all sectors of healthcare. For chemotherapy, the prescription will consist of a dose of selected drugs administered in a defined pattern over an agreed period of time. With unsealed radionuclide source therapy there will be a prescription, as for chemotherapy, which will specify the amount of activity to be administered rather than a patient radiation dose.

4.27 In radiotherapy, the prescription will consist of an agreed dose, to be delivered over a number of fractions or episodes of treatment, typically between 4 and 30.

Definition of treatment volume

4.28 The treatment volumes, that is the size, shape and site of the disease, will normally be defined either by the use of radiographs or by cross-sectional imaging involving CT or MRI.

4.29 Film-based imaging is increasingly being replaced by new digital techniques. The role of telemedicine in cancer care is discussed below.

Radiotherapy support scanning by CT and MRI

4.30 In addition to the routine diagnostic use of cross-sectional imaging, some additional imaging, directly related to the business of planning treatments rather than diagnosis will also be required. Much of this will be by CT, though some use of MRI may also be appropriate.

4.31 The data generated by these scans is transferred to a specialised computer or workstation that is devoted to radiotherapy treatment planning (RTP). All of this data is then used in the construction of a radiotherapy treatment plan, the

purpose of which is to generate treatment parameters for use on a linear accelerator, brachytherapy or Cobalt 60 treatment machine, etc.

4.32 This package of data is checked by a clinical oncologist and then logged for use by the department in the treatment of the individual patient.

4.33 In recent times, European legislation and Codes of Practice in the UK have required that for each patient two treatment plans be created, each by a different method. In practical terms this requires two technologists using at least two standalone or networked workstations.

Radiotherapy treatment simulation

4.34 This process is conducted in the simulator room and involves the use of an X-ray machine that emulates the geometry of radiation beams to be used for the patient on the linear accelerator.

4.35 The majority of radiotherapy patients receive simulation unless their treatment regime is very simple. Some patients may occasionally be simulated more than once.

4.36 Modern practice and design of simulators incorporates the use of image intensifiers similar to those used in diagnostic imaging departments to acquire the relevant images and in some cases reconstruct the data from different views to form low-resolution CT cross-sectional images. This latter feature usually requires additional equipment.

4.37 Alternatively, for film-based solutions, either the data acquired using the image intensifier is sent directly to a laser imager located within the department, or images are collected directly onto film using cassette holders integrated within the simulator's configuration.

4.38 A typical room layout incorporating facilities for digital imaging and treatment planning 'Simulator with treatment planning and conference suite' is shown in Appendix 2: Room layouts.

Image-based treatment validation and portal imaging

4.39 Portal imaging systems permit linear accelerator systems themselves to create images of the patient's anatomy. This gives a final check that the correct volume is being irradiated.

4.40 If hard copy film-based portal images are acquired then a separate unit, a digitiser, may be required. The digitiser will convert the images into a digital data format in order that they can be compared with simulation and planning images.

4.41 In the future, as treatment technologies become more sophisticated, image based validation to check that treatments are being delivered correctly will be an important element.

Treatment verification records and management (VRM)

4.42 The overall approach to radiotherapy treatment management should involve the use of a VRM or similar computer to bring together many of the data treatment elements referred to elsewhere in this section. In essence, the verification, record and management computer is responsible for maintenance of all the data concerned with treating the patient. Alternatively some cancer care centres may continue with paper-based records, which will require physical storage.

4.43 While the VRM concept is described here in the context of radiotherapy, verification and management elements can also be applied to a similar process in chemotherapy and indeed other forms of cancer treatment.

Review process

4.44 For some patients the cancer or tumour will regress under treatment and this regression is fairly constant and readily understood so that the treatment regimes need not be varied sharply. However, for others, initial treatments may not be successful or complications may develop. In these latter cases, which are not uncommon, patients should be reviewed regularly so that their condition can be assessed and alterations made to their treatment as necessary.

Palliative care measures

4.45 The purpose of palliative care is to control symptoms and alleviate suffering in patients who cannot be cured of their disease. It is important to understand that while palliative treatment regimes may be somewhat simpler than their radical alternatives, this does not imply any reduction in the quality of the care delivered.

4.46 Over and above the physically defined parameters, the palliative patient, sometimes in common with radically treated persons, may require periods of care in a hospice or psychological care/counselling. The quality of this treatment is just as important as that used to regress tumours or control pain.

Hospice services

4.47 The last 15 years have seen a marked rise in the provision of hospice services, mainly through the NHS and the charitable sector. The aim of hospice services is to provide a supportive and caring environment away from the hospital setting often, though not always, in pursuit of palliative care.

4.48 The hospice movement supports respite care services. These are often helpful to people caring for friends or relatives at home. For example, a cancer patient may attend a hospice on either a day or residential basis, thus relieving the carers at home, or the carers themselves may attend support sessions at the hospice, leaving others at home to care for the patient.

4.49 A trained specialist in palliative care will lead the palliative care team. The team may be based in a hospice unit, in a hospital support team or as a home support team within a community primary care trust. Palliative care units and teams may be funded by the NHS or in the charitable sector. In recent times, joint health authority and charity funding has emerged. Many specialist posts and initiatives in palliative care are pump-primed by the Cancer Relief Macmillan Fund.

4.50 The detailed information on operational requirements and facility design will be available in the third document of this set of guidance.

Brachytherapy

4.51 This is a special form of radiotherapy. A patient will initially undergo surgery involving the insertion or implantation of applicators for use with radioactive materials. This may be carried out in operating theatres, or, in some cases, in the simulator room.

4.52 Radioactive sources may then be inserted by mechanical means through the applicators under computer control with all persons, other than the patient, excluded from the treatment suite. Some manual insertion is still used but this is a declining practice largely because of safety difficulties.

Scheduling requirements

4.53 Recent reports from the Royal College of Radiologists and other learned bodies have stressed the importance of accurate scheduling in the entire process of patient care in cancer care services. This implies a built environment and equipment portfolio designed to encourage reliability and prevent delays.

5. Special considerations in paediatric care

Basic specialisations and working definitions

5.1 Cancer in children and young persons occurs at a low rate compared to that in the general adult population. The nature and characteristics of disease in these groups differs in many cases from that observed in adult cancer care centres and may include disorders which are diagnosed at or even before birth.

5.2 Children are for this purpose defined as being from birth to 14 years of age while the paediatric group also includes young persons aged from 15 to 21 years.

5.3 Paediatric care may be given in dedicated cancer care centres or in specialist departments within a more general facility. At present in Scotland, all paediatric radiation oncology is provided within adult centres and current workload may not justify special paediatric centres. Special facilities are needed for only a limited range of clinical services but the long-term nature of much of the care, including prolonged in-patient stays, requires the provision of family and schooling accommodation. Delicate social factors are also influential on design and department character.

The paediatric patient journey

5.4 The paediatric patient's journey will be determined by the child's age and disease. The rapid onset of many childhood cancers is also a significant factor in the care approach and in the speed and intensity of treatment applied.

5.5 The journey will begin with a paediatric assessment requested either by a family GP or directly from neonatal care. This process may be urgent and will be backed by pathology and imaging tests as needed; an in-patient stay may commence at once.

5.6 For many children the prolonged nature of the treatments may mean that the cancer journey must also incorporate other aspects of normal life and personal development for the child, family and others. This includes the need to provide facilities that will support a hospital-based community within which the child or young adult lives.

5.7 Further special journey elements will occur in the case of certain patients, including those with the blood disorder leukaemia which will potentially require treatment by total body irradiation. The effects of treatment include a great reduction in the body's immune response and protection against infection is accordingly required. The patient journey will therefore involve remaining in an aseptic environment for long periods of time.

5.8 Although the child will spend much time within the confines of the paediatric cancer facility, economic and practical considerations mean that the journey will often embrace visits to adult facilities, particularly for some diagnostic procedures and radiotherapy.

5.9 Although used only when essential, the administration of anaesthesia and/or sedation is common for children and accordingly modifies the journey when compared to an adult journey. The giving of anaesthetics may occur locally to the treatment facility or in procedure rooms on the ward.

5.10 The nature of paediatric cancer and its sensitive treatment is such as to require high levels of mutual commitment and continuity, possibly extending over many years. The patient journey reflects this and may include continued visits to the same care provider even if the family moves elsewhere. Such visits may be for additional treatment but social needs and counselling are equally important.

Clinical background

5.11 Diagnostic procedures for paediatric cancer differ little from their adult counterparts but the need for anaesthetics will, in many cases, extend the time taken to investigate, and will also influence facility design.

5.12 Discrete children-only facilities are not generally justified on clinical grounds but workload may mean that dedicated CT scanning and ultrasound rooms are appropriate. Access to positron emission tomography (PET) scanning is of particular importance. This may involve increased provision or efficient transport and communication with established service providers.

5.13 Treatment involving chemotherapy and/or radiotherapy is commonly applied. Paediatric cancer surgery is a highly developed speciality. Generally adult facilities can be effectively shared however, the provision of dedicated chemotherapy is relatively easy to achieve and generates significant benefit in terms of patient care standards and social sensitivity.

5.14 Both unsealed or liquid radioactive source treatments as well as sealed/solid source brachytherapy can be useful though the frequency of use is low.

5.15 Cancer treatments are often quite harsh and may themselves cause a controlled level of damage or injury. Accordingly, long-term follow-up of these patients is especially important and may result in visits by patients from children who have moved into an older age group.

5.16 Much of the above may be used in connection with ‘play therapy’, which has been found to usefully reduce the extent to which sedation, particularly for immobilisation, is needed. Play therapy would typically involve toys and games that, safely and in a friendly fashion, reflect the treatments which the child may later encounter.

5.17 In the modern era much is done to maximise the extent to which the child may be cared for in his or her own home. The use of outreach nursing, which must be facilitated by the cancer care centre, is particularly helpful.

Special accommodation requirements

5.18 Some of the accommodation does not differ in character or design from that used for adults and may indeed be shared facilities. However, a number of special issues do arise and some of these are observed as key to successful patient care.

5.19 In radiotherapy the linear accelerator bunkers will require special design elements to give the long source-to-target distances required for total or whole body irradiation. Special facilities to soften the environment in a child-friendly way should also be considered.

5.20 As treatment interruptions in some radiotherapy regimes may be especially harmful to children, the need to provide sufficient facility as to give effective back up or redundancy is particularly important.

5.21 Linear accelerator and other teletherapy rooms for paediatric use will always require anaesthetic and monitoring facilities. Consideration should be given to the use of permanently installed monitoring. Closed-circuit TV (CCTV) observation is always essential. Colour equipment must be used. Voice communication with the patient, accessible to the parents/nurses etc., is a very useful enhancement in reducing fear and gaining patient co-operation.

5.22 The provision of brachytherapy rooms for low or medium dose rate sealed source treatments is a difficult issue. Paediatric patients may be expected to benefit from these rooms being specially adapted and adjacent to other children's facilities. However, the frequency of use may be low so that for smaller centres a compromise with adult facilities may be essential for cost reasons. No special challenge arises for high dose rate facilities and the adult facility will always be used.

5.23 Unsealed source treatments present a particular challenge, given the need for a child-friendly yet specialised side ward environment which cannot be used for other purposes for much of the time due to radioactive contamination. The use of adult facilities is feasible but difficult in both nursing and social terms. The giving of such treatments on the open ward is unlikely to be lawful under the Ionising Radiations Regulations 1999. See Appendix 2: Room layouts for an illustration of a modern treatment room, 'Iodine treatment room with en-suite shower/wc'.

5.24 Ward accommodation must necessarily feature a high density of single bedrooms. Accommodation for parents local to or within side rooms is needed. The designs must be such as to allow for personalisation of the rooms by children who may remain for long periods of time. In view of practical considerations of travel times, etc., full family units will be required. These

should have adequate accommodation even for an extended family on a stay of considerable duration. The use of anaesthetics will increase the number of treatment rooms needed on each ward or unit.

5.25 Well developed procedure rooms or a minor procedures theatre will be needed in or adjacent to wards. This will be used for bone marrow transplant (BMT) and a range of other procedures including lumbar puncture. This shall incorporate filtered air ventilation and anaesthetic facilities with scavenging. A recovery room will be needed.

5.26 Special isolation facilities for those with compromised immunological status or infection vulnerability will be essential. These are of specialised design and will also have pressure control filtered ventilation systems.

5.27 As might be expected, family members may themselves require social and psychological care. This will typically be facilitated within the paediatric cancer facility. Meeting rooms and accommodation for family support groups will be needed.

5.28 Long in-patient stays necessitate on-site education facilities. This must include school rooms and facilities for the accommodation of teachers and the preparation of education materials.

5.29 Teenage patients will require an informal room with entertainment facilities. Care must be taken in siting this to avoid noise nuisance and to ensure security.

5.30 Paediatric rehabilitation will be essential as a dedicated facility and should include a modest gymnasium.

5.31 Dedicated information and help centres will be needed for paediatric facilities. The material stocked should differ noticeably from that available in adult facilities.

6. Diagnostic services including pathology and specialist radiology

Facilities for diagnostic techniques

Introduction

6.1 Diagnostic medicine is a key, intrinsic feature of high-quality patient care in the whole range of cancer diseases. Much of the science is highly developed and recent years have seen a high pace of advance.

6.2 The role of the diagnostic services extends to a number of features which are aimed at enhancing patient survival rates and minimising pain and discomfort or any feelings of defeat. The essential elements include primary or preliminary diagnosis, differential diagnosis, which specifically refines the picture, and tumour staging coupled with treatment monitoring.

6.3 Fundamentally the services required divide into three categories with variable levels of specialisation to cancer. The non-specific techniques are mentioned but not described here. The categories are: pathology services; imaging including cross-sectional work; patient and physiological assessment. The latter is general and not detailed here.

Pathology services

6.4 Pathology services will be provided by the parent institution related to the cancer care centre with the possible exception of specialised histopathology and cytology which are related to the examination of cell types sampled from the patient, in some cases by biopsy. These services may be specifically developed for cancer care centre use or be part of that centre. Other services such as clinical chemistry, biochemistry, haematology and microbiology are all important to cancer. However, other than refinements to the range of tests offered and a possible need for an increase in service capacity, the descriptions given in NHSScotland's guidance Scottish Hospital Planning Note 15 ‘Accommodation for pathology services’ apply without change where a cancer care centre is present.

Imaging services

6.5 The importance of these has risen sharply in recent years and given rise to a national modernisation programme which has increased the quality and capacity of the service offered to patients. This work has focused particularly on CT and MRI though almost all modern imaging techniques are used in connection with cancer. Again the parent institution will provide the majority of the service and an influence on capacity requirements in general X-ray,

vascular imaging services and ultrasound will be found. The role of image-assisted minimal invasive therapies is also developing rapidly and again has capacity implications in fluoroscopy, ultrasound and cross-sectional imaging (CT and MRI).

6.6 Minimal invasive therapy has a marked influence on the design of the rooms used, particularly in fluoroscopy and angiography. This is described in detail in Scottish Health Planning Note 06 'Facilities for diagnostic imaging and interventional radiology'.

6.7 Specifically within cancer care centres the intensive use of CT, and increasingly MRI, means that dedicated units will be required as an essential feature. These are described in further detail below as well as in NHSScotland's guidance Scottish Health Planning Note 06 'Facilities for diagnostic imaging and interventional radiology'.

General pathology

6.8 The reader is referred to NHSScotland's guidance Scottish Hospital Planning Note 15 'Accommodation for pathology services'.

Histopathology

6.9 These laboratories, which may be part of the general histopathology laboratory complex, are used as part of the national cervical screening programme. Although cervical disease can be treated by the Manchester brachytherapy system and also by medical oncological or chemotherapy means, early diagnosis is known to have a significant effect upon prognosis.

6.10 Cervical screening involves the taking of a cell scrape from the cervix in a room that ensures effective clinical work under discreet conditions. The so-called 'cervical smear' is transferred to a laboratory for preparation and microscopic examination by histopathologists and specially trained screening staff.

6.11 The Medical Devices Agency (MDA) document 97/31/S has generated advice and standards in this area. In addition, NHS Estates' guidance HTM 67 'Laboratory fitting out systems' and Scottish Hospital Planning Note 15 'Accommodation for pathology services' also provides advice in this respect. The histopathology laboratories used for these purposes differ little from those generally described by NHSScotland for this area of pathology. However, recent work has drawn attention to a number of key items:

- the standards of concentration and care required to achieve reliable diagnosis in this area are particularly high. Accordingly, the environment must be quiet and the number of persons accommodated for the size of laboratory will be relatively low. The use of carpets in these laboratories is increasingly widespread because of the added comfort and noise suppression which this form of floor surface can provide;

- long periods of work in which the operator focuses carefully through a binocular microscope to examine specimen slides can lead to eye fatigue. Accordingly, windows permitting the operator to view a distant horizon and relax the eyes by focusing on infinity are needed;
- seated ergonomics have been demonstrated by independent study to be important in this area. Variable height seating using stools or chairs equipped with backrests, coupled with a similar ability to vary the height of the working surfaces which support microscopes and other equipment has been held to be necessary. Care is needed over lighting levels and variable control. Light diffusion within the room is also a key factor.

General radiology

6.12 The reader is referred to NHSScotland guidance SHPN 06 'Facilities for diagnostic imaging and interventional radiology'.

X-ray mammography

6.13 This modality has two related basic methods by which diagnosis can be achieved. The first of these is high-resolution X-ray imaging while the second uses a special form of such imaging to guide a breast biopsy. The material removed at biopsy is then sent for laboratory characterisation in histology in order to detect the presence or absence of cancer cells.

6.14 The service is often intimately associated with a breast care unit, which is a key feature of most adult cancer care centres. The imaging technique will be used early in the cancer journey for those with suspected or confirmed breast disease.

6.15 A technology change is in progress at the time of writing and as a result some units may continue to be provided with film-based imaging whilst others are moving to filmless techniques involving digital radiography (DR). The former requires very high quality film processing in a small but specially equipped darkroom. Daylight film processing is available for mammography but is less useful in the low throughput cancer care centre environment than is the case for high-volume scanning conducted elsewhere. Digital imaging removes the need for a darkroom but creates a necessity to house imaging viewing and processing computers, and requires a local area network (LAN).

6.16 During imaging examinations, mammography X-ray suites will be required to accommodate only the specially trained radiographer and the patient within the X-ray or examination room itself. However, when the facility is used for needle aspiration or biopsy employing stereotactic methods and equipment, occupancy pressures could be three or four persons. These will include a radiologist in addition to the patient and radiographer. Preferably a nurse will also be accommodated, though this is dependent on local practice.

6.17 The mammography room itself will be accompanied by modest waiting facilities, typically large enough to accommodate six people. In view of the potentially stressful nature of the examination, the waiting area should be of a quiet and relaxing character and positioned away from busy circulation space, etc.

6.18 The radiation quality or beam harness used in mammography is very low and soft. Accordingly, while the X-rays are classified as penetrating, they are much more heavily attenuated by ordinary building materials, including dense studded partitions, than is the case in broader general X-ray. This being the case, levels of shielding in terms of lead equivalence are substantially lower than encountered elsewhere. Typically, equivalence of less than 0.5 mm of lead will be needed to generate levels of attenuation which will protect persons in accordance with the requirements of the Ionising Radiation Regulations 2000.

7. Specialist cross-sectional imaging and positron emission tomography

Introduction

7.1 There is a debate over the location of imaging provision. The overwhelming view of diagnostic radiologists is that this should be integrated with the tertiary hospital's department to provide the most efficient and cost-effective service overall.

Computed tomography (CT) suite

7.2 CT scanning is an X-ray diagnostic technique. The basic principle involves an X-ray source or tube which rotates quickly about the patient. The X-ray beam is attenuated by the dense structures, such as bone, within the patient's head or body and the resulting changed beam is intercepted by an imaging detector mounted in a gantry opposite the X-ray tube. The image is then produced by the use of a powerful computer and displayed on a monitor or printed to laser film. Essentially, the product images are slices through the anatomy at selected points.

7.3 The image is captured in digital format for transmission over computer networks both for diagnostic viewing and also for special use in radiotherapy treatment planning (RTP), for which CT is increasingly essential. This latter function requires the provision of one or more CT scanners within a cancer care centre and good standards of access in cancer care units.

7.4 Recent developments in CT have led to 'spiral CT' techniques for faster image production and shorter scanning times giving increased capacity. Furthermore, 'multi-beam' CT is now being commonly installed with still further benefits for throughput. These new machines often enable minimal invasive procedures such as tumour biopsy.

7.5 Technological developments in the acquisition and processing of CT images are enabling cancer care centres to use CT simulation instead of traditional simulation for many, but not all, simulated treatments in radiotherapy. This development is expected to lead to a reduction in the number of simulators employed but an increased need for CT, with larger centres requiring two machines.

7.6 The machine consists of three major modules. These are the scanning gantry and patient support, a control console and a number of electronics or computing racks. A dedicated control room will house the console and provide a direct view of the scanning room through an X-ray protected window. The electronics racks will be placed in a dedicated 'machine room'.

7.7 As the scanning process involves the use of X-rays there is a need to construct the walls, doors and possibly windows of the scanning room from high-density X-ray attenuating materials. The shielding specifications must meet the requirements of the Ionising Radiation Regulations 2000 and the advice of the local Radiation Protection Advisor (RPA) must be sought by statutory obligation.

7.8 Visual and audio contact with the patient during the CT scan is maintained through a protective glass screen supplemented by CCTV and intercom. Patient access on foot, in wheelchair, bed or trolley is obligatory.

7.9 The reader is referred to NHSScotland guidance SHPN 06 'Facilities for diagnostic imaging and interventional radiology' for further details.

7.10 **Components of a CT suite**

- Scanning room;
- Scanning control room;
- Data/image review room;
- Patient preparation room;
- Clean utility, where applicable.

Magnetic resonance imaging (MRI) suite

7.11 MRI is a diagnostic facility utilising magnetic resonance signals to generate detailed cross-sectional images at selected blocks or slices across the length of the patient's head and/or body. The technique is powerful in the ability to image both normal and tumour tissues at high resolution and often with good sensitivity to the presence and nature of disease. Use of MRI in the support of treatment through both minimal invasive therapy and radiotherapy is also established.

7.12 In outline technical terms, MRI combines a powerful magnet, smaller time-varying magnetic fields, radio signals and a sophisticated computer to produce high-quality images that display the soft tissues of the body. The digital information generated can be used to form cross-sectional, three-dimensional or moving images which may be stored and distributed in a variety of ways. This can be a complex process but in essence the images generated may be viewed on a television monitor or produced as laser hard copy, similar to X-ray film.

7.13 The scanning process takes place in a room which is constructed from normal building materials but which is surrounded internally by a Radiofrequency (Rf) cage. The cage is essentially a bonded wire or sheet screen used to protect both the MRI and adjacent equipment from unwanted Rf signals or radiation. The strong magnetic field generated by the MRI unit may also give rise to a design challenge; part of the field described as 'the stray magnetic field' will be present in the surrounding environment. In the past this frequently gave rise to the need for magnetic shielding in the form of ferrous sheets or plates fitted to

the room walls outside the Rf shield. Current units, often including the increasingly common 1.5 Tesla (T) type, have very effective 'self shielding', reducing or removing the external shielding requirement. Protection against the magnetic stray field down to 0.05mT or less is needed in order to protect persons, particularly those fitted with cardiac pacemakers, and also to ensure normal operation of electronic equipment in surrounding rooms.

7.14 It should be noted that modern high-gradient MR systems generate a great deal of noise.

7.15 The machine consists of three major units. Largest and weighing two to five metric tonnes is the gantry unit which consists of the imaging magnet and patient support system. A control console will be required and is housed in its own room, adjacent to the scanning room, and with a sight provision generated by a special window which is itself part of the Rf shield, as is the special scanning room door. Lastly a number of electronics racks must be accommodated in a separate but adjacent machine room.

7.16 Visual and audio contact with the patient during the scan is maintained through a protective glass screen supplemented by CCTV and intercom.

7.17 Cryogenic gases will ordinarily cool the strong magnet though resistive electromagnets and permanent magnet types are also used in smaller, less capable machines. Where cryogenic gases, such as liquid helium, are used, an emergency external 'quench' pipe will be essential and the need to bring cryogenic materials to the suite must also be considered.

7.18 Much of the suite design is orientated toward producing a patient-friendly environment but the existence of hazards and the need for control of access also has a strong influence.

7.19 The reader should consult MDA safety publications and NHSScotland guidance Scottish Health Planning Note 06 'Facilities for diagnostic imaging and interventional radiology'.

7.20 **Components of an MRI suite**

- MRI scanning room;
- Scanning control room;
- Patient waiting and changing area;
- Machine and computer room;
- Outer controlled area;
- Data/image review room.

Positron emission tomography (PET) suite

7.21 This relatively new technique has gained considerable importance in the United States and some other overseas areas but is in the relatively early stages of development within the UK. The principle cancer application is in the detection and evaluation of possible secondary cancer growths or metastases. PET also has a number of important non-cancer applications in the neurosciences and elsewhere so that shared facilities may be a relevant consideration.

7.22 The technique uses very small amounts of glucose sugar in a modified form (DG), to which trace quantities of the positron-emitting radioactive material Fluorine-18 are attached by chemical bonding to produce FDG. Positrons are novel anti-matter particles which annihilate matter to generate two gamma rays, which travel in opposite directions to each other. This special property allows a positron camera to detect, and by tomography locate, the position of the radioactive material within the patient's anatomy. This in turn highlights the presence of secondary tumour growth.

7.23 In clinical terms, although as yet unproven, the technique may help doctors to determine which patients would benefit from radical (curative) treatment and which should proceed to palliative care and a pain control programme. The progress of treatments may also be monitored by this modality or approach.

Practicalities and the built environment

7.24 Producing FDG is very difficult, it can only be produced by a cyclotron; it must be an infection-free material; and Fluorine-18 has a short half-life, only a few hours. Accordingly, specialist and quite major facilities are necessary. These may occasionally be on-site with a large cancer care centre but, more commonly, will be located in regional centres or produced commercially. The production centre will need to be within three to four hours transport time of the cancer centre if the material is to be usable.

7.25 The patient journey requires attendance at a PET scanning centre, which will not necessarily itself be located close to the cancer care centre, though some logistical advantages may be observed in easy patient flow and care. It is important that the patient is very calm before the scan can successfully be undertaken and accordingly the reception and waiting areas should be particularly restful in character. A similar argument applies to the transfer of non-ambulatory patients. The giving of muscle relaxant drugs within a calm individual waiting or preparation room is often regarded as standard practice.

7.26 The patient must change into an examination gown and all metallic objects, etc, placed safely in a locker or similar repository.

7.27 The FDG is given as an intravenous injection and after a waiting period, again in a very calm environment, the patient will be taken for scanning. This work uses a positron camera or in some cases a modified nuclear medicine gamma camera to generate the tomographic scan described above. This scanning

process takes about 45 minutes and again the scanning room must be calming, and reduced but safe lighting levels are often used.

7.28 It is important that WC facilities for the exclusive use of the patients are provided. These must be close to the waiting and clinical areas of the PET diagnostic suite. There must not be steps, floor slopes, etc., in the linking space as these may increase the patient's exertion and compromise the quality of rest required.

7.29 After scanning, the recovery time is short and the majority of patients may leave for home. However, as the patient is slightly but not insignificantly radioactive, special transport arrangements or a delayed departure may be necessary. These transport requirements may involve the use of patients', relatives' or friends' vehicles and thus special thought must be given to convenient vehicle access and parking.

Safety and special design considerations

7.30 The radioactive material used, and medical constraints present, have important considerations for building design. F-18 has higher radiation energy when compared with most, if not all, nuclear medicine radioactive materials. This and a number of similar factors gives rise to an increased need for heavier radiation shielding and protection by the use of distance and other controls.

7.31 In suite design, the use of shielding local to the radioactive materials as well as within the building structure should be considered in consultation with the local RPA. The shielding will consist of lead protective containers and enclosures combined with dense block wall construction. The rooms used to store and separately administer the FDG should be separated by at least a few metres from the scanning room in order to avoid unwanted detection of stored materials by the camera during scanning. The scanning room will require an adjacent control room with shielded viewing window and CCTV.

7.32 Protection against radioactive contamination is important and the essential measures differ only in detail from those used in nuclear medicine. However, the standards which must be achieved are higher and place a premium on detailed design and the selection of impermeable materials.

7.33 The need to constrain both the radiation and radioactive contamination will also affect the care of inpatients and the environment in which they are nursed. The spacing of beds in wards may require review and the presence of low-level radioactivity in the patient's body fluids gives rise to the need for monitoring in respect of contamination and the provision of modest containment facilities (see Section 16). The bedding and other materials brought into contact with the patient may need to be stored separately as part of this containment. Equally the provision and storage of a 'spill kit' is essential in order to deal safely with the results of minor incidents or incontinence.

7.34 There are requirements under the Radioactive Substances Act that relate to storage, use and disposal of radioactive materials. These generate many

implications particularly in terms of security against source theft and the possibility of fire. Disposal by radioactive decay in short-term stores specially constructed and shielded for the purpose will be needed.

7.35 The reader is referred to NHSScotland's guidance SHPN 06 'Facilities for diagnostic imaging and interventional radiology'.

7.36 **Components of a PET diagnostic suite**

- Patient scanning room;
- Scanning control room;
- Patient preparation and pharmaceutical administration area;
- Pharmaceutical preparation laboratory;
- Waste disposal facilities;
- Patient rest area.

7.37 An example layout for a PET diagnostic suite is given in Appendix 2: Room layouts.

8. Therapeutic services including radiotherapy and chemotherapy

Radiotherapy

Introduction

8.1 The provision of radiotherapy is a key feature of all cancer care centres.

8.2 There are three forms of radiotherapy treatment using sealed and unsealed sources of radiation: **teletherapy** in which an external beam is generated by a machine source of radiation, **brachytherapy** in which a tumour is treated by placing a radioactive source inside the body. The source of radiation is normally placed into a tube or applicator device that has been implanted or inserted at surgery. This approach of placing the radioactive source after surgery is known as 'afterloading'. The insertion of the radioactive source can be manual, or more commonly, conducted by a remote afterloading machine. Among many advantages, afterloading protects the staff against the problems and doses associated with handling radioactive materials in the operating theatre.

8.3 Another way of treating disease from within is by using unsealed radioactive sources. These are usually administered to the patient in the form of a liquid, taken as a drink, a capsule or by intravenous injection. Guidance on the use of unsealed radioactive sources is contained in Chapter 10.

8.4 All three forms of radiotherapy outlined above require dedicated facilities which must be carefully designed to match ergonomic, patient care and safety requirements. Safety will include protection against fire, electrical hazards and radiation and radioactive material.

Radiotherapy equipment and outline treatment room requirements – teletherapy

Linear accelerator

8.5 This is a powerful electrical device which, as the name suggests, accelerates electrons to very high energies by using radio frequency waves, generated by a magnetron or klystron within a high-vacuum waveguide. The electrons are then either emitted into the air as a beam directed towards the patient or used to produce X-rays by being guided into a transmission target. The beam is then shaped to match the treatment requirements using an electron applicator or X-ray collimating jaws as appropriate.

8.6 This specialist equipment requires installation in a purpose-designed linear accelerator bunker with very heavy protective shielding built into the construction. Traditionally reinforced concrete and steel have been used but

new materials, for example, 'Ledite', (see Appendix 2: Room layouts) are now providing alternative approaches, which may have advantages in terms of reusability and reduced footprint. The bunker entrance will normally be protected against the escape of X-rays into the adjacent environment by a concrete maze; however, some recent designs have seen the reintroduction of heavy protective doors without the provision of a maze. In the past, Barytes bricks have also been used for protection and they may still have a use in refurbishment works.

8.7 Linear accelerators may be categorised as single mode or multi-mode. The former are used for X-ray treatments only, while the latter can produce external electrons in addition to X-ray beams. Multi-mode linear accelerators may have special built environment requirements over and above an X-ray protective bunker, particularly if used to generate X-rays above a defined energy threshold. These relate to the need to protect persons against unwanted neutrons produced by interactions involving the high-energy X-rays. Neutron attenuation and absorption favours the use of light materials such as wax and plastics.

8.8 Radiotherapy treatments must be precise and accurate in terms of aiming the beam at the intended target. This requirement means that almost all linear accelerators use a base frame set into the floor which links the accelerator gantry to the patient support device or couch.

8.9 The recent introduction of two new technologies has had a small but important influence on treatment room design. The first of these is the multi-leaf collimator, a device that accurately shapes the beam to the tumour and has reduced the need for special low-melting point (LMP) lead blocks which were previously used for this function and required local storage. Secondly, imaging is now possible before or during treatment by digital means, using electronic portal imaging.

Cobalt 60 machines

8.10 This technology is based upon the production of a gamma ray beam from a very large cobalt radioactive source contained inside a protective housing equipped with mechanical shutter and basic beam-shaping collimators. The relative simplicity of such machines is an advantage but a lack of flexibility and the environmental challenge of radioactive waste disposal mean that only small numbers of machines remain in use today. The possibility of new installations or upgrades cannot however be excluded.

8.11 The treatment rooms or bunkers used are similar in concept to those described for linear accelerators, but the special high-energy considerations are not relevant.

Superficial X-ray treatment machines

8.12 These devices use conventional, though powerful, X-ray tube technology to produce lower-energy treatment beams. The emergence of linear accelerator electron treatments has reduced demand for superficial X-ray treatments but some disease conditions remain more effectively treated with this older technology.

8.13 The X-ray tube is mounted on a simple but robust and accurate floor or ceiling suspension and is powered by a conventional X-ray generator system. The treatment couch will be mobile and is not mechanically linked to the X-ray tube mounting.

8.14 Treatment rooms are similar to those used in diagnostic X-ray and may incorporate thin lead shielding or be constructed from conventional dense building materials. Protective doors and viewing windows will also be used. A maze is not needed in protection against these low-energy radiations.

Orthovoltage X-ray treatment machines

8.15 In common with superficial X-ray treatment machines, these X-ray systems use a conventional tube and generator though they are considerably more powerful than their superficial counterparts. The need for these machines is in marked decline and it is likely that few will be installed in future unless new clinical applications develop.

8.16 The treatment rooms are more heavily shielded than those used for superficial treatment and a small maze is a viable alternative to heavy door construction.

Radiotherapy equipment and outline treatment room requirements - brachytherapy

Manual afterloading

8.17 This technique is declining in use but may be offered for Iridium 192 wire treatment of tongue or breast as well as a number of other applications. The approach involves the patient in a visit to the operating theatre for the insertion or implantation of applicator tubes under general anaesthetic. This is followed by the insertion of the pre-prepared encapsulated wires in a suitably shielded single patient side ward.

8.18 The shielding is intended to protect clinical and nursing staff as well as visitors and the public. As a result of these requirements 'shadow shields' are more likely to be employed. These consist of very heavy lead castings or plates supported on mobile frames and strategically positioned to shadow key areas around the patient's bed. In modern installations structural wall shielding is also likely to be employed but local RPAs must be consulted on this issue.

8.19 The wires are prepared for use in a shielded workstation within a medical physics sealed source laboratory. Such facilities contain the shielded

workstation together with a storage safe for the sealed sources. The preparation varies with the treatment requirement but will always include assay of the radioactivity present and may involve source sterilization.

Machine afterloading

8.20 In order to reduce operator dose and afford greater treatment flexibility, the widespread introduction of machine-based afterloading has occurred. In this group of techniques, the source is contained within a shielded store built into the afterloading machine. Using sophisticated computer-based control, the machine achieves mechanical or pneumatic transfer of the source(s) from the store into the applicators which have been previously implanted or inserted in the ward or operating theatre environment.

8.21 The sources may be automatically withdrawn to the storage safe when nurses, visitors etc enter the room. Safety interlocks are always applied. With the sources withdrawn, nursing may be conducted in an unhurried and normal way. Compliance with IRR requirements is also aided substantially.

8.22 The treatment room will always be wall rather than shadow shielded, though the level of shielding required will be greatly influenced by the dose regimes as outlined below. If afterloading systems are being used in a multi-storey building, then the shielding will be required to the floor and ceiling. All control functions and some routine monitoring of the patient will be conducted from a shielded area outside the treatment room. The use of CCTV observation is helpful in removing the need to interrupt treatments by the withdrawal of sources on an excessive number of occasions. Intercom communication with the patient is an essential requirement. A typical machine afterloading system is shown in Figure 7.

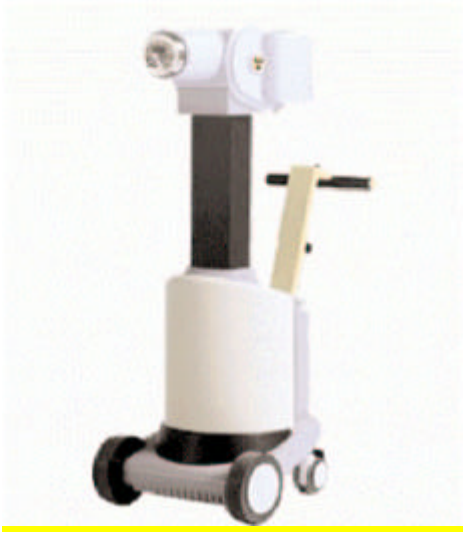


Figure 7: Machine afterloading system

Low dose rate (LDR) machine afterloading

8.23 In LDR brachytherapy the treatments will last from 18 to 48 hours in terms of source exposure time. Only a single treatment fraction is used. The patient will remain in bed within the shielded room for a total of about two days after which the applicator tube will be disconnected from the machine. Following this, the patient will undergo applicator removal surgery on the side ward or in the operating theatre.

8.24 In common with medium dose rate (MDR) treatments, the tumour volume is continuously irradiated throughout the source exposure time. The treatment machines are also of similar design to those used in MDR, that is to say self-contained units of 150 to 250 kilogrammes weight and being less than two metres tall. Some machines require a separate compressor mounted or housed so as to control noise. In the UK the majority of systems employed use multiple Caesium 137 or Iridium 192 radioactive sources. A minority of currently installed units may still support the use of radium and gold sources in some LDR applications.

8.25 In the modern era, treatment flexibility requirements will give rise to the need for multi-use brachytherapy facilities. It is envisaged that a single shielded side room with shielded en-suite shower room and toilet will be provided. With care in design this may be used for manual afterloading, LDR and MDR treatments as required. The room may also be used for routine nursing but not with unsealed source treatments.

8.26 The control panel will be mounted in a secure location outside the treatment room and is duplicated on the machine itself. TV monitors must also be located so as to preserve privacy while permitting observation by nurses. The use of independent radiation monitors is advised.

8.27 The provision of external windows is desirable and may be achieved at ground level by the use of shielding walls outside, acting as shadow shields to the external environment. The area between the window and shielding wall will require rigorous access control.

Medium dose rate (MDR) brachytherapy

8.28 MDR treatments typically take around two to four hours source exposure time, depending on the type of treatment undertaken. Unlike pulsed dose rate (PDR) brachytherapy, the tumour is continuously irradiated. The treatment prescribed may include the use of multiple or single radioactive seeds. These machines tend to be larger and carry more sources than a high dose rate unit, described below. The majority of sources utilised in the units are either Caesium 137 or Iridium 192. In common with LDR, some manufacturers build machines that incorporate the option to treat two patients simultaneously. This will require two adjacent shielded treatment rooms.

8.29 Where suites are required to facilitate MDR, the design will be broadly as for that described above. However MDR brings with it additional shielding requirements and these may have greater structural implications.

Pulsed dose rate (PDR) brachytherapy

8.30 In this instance, a single radioactive Iridium source is used. This has a level of radioactivity of about three times that used, per source, in MDR treatments. Treatment times last up to 48 hours.

8.31 In this treatment method, the single source is moved into an applicator within the treatment site for up to 10 minutes per hour and is then retracted by the brachytherapy treatment unit and placed into the next tube or applicator location. The principal benefit of this treatment is to obtain the same radio-biological properties as LDR brachytherapy treatments and yet allow the use of a single source and greater flexibility in nursing time.

8.32 Suite design is as described for LDR but with reconsideration of the shielding requirements. High instantaneous dose rates make the use of external windows more difficult and the advice of local RPAs must be sought.

High dose rate (HDR) brachytherapy

8.33 This modern patient treatment approach differs in many respects from those discussed for LDR/MDR and PDR above. The dose rates used and levels of radioactivity are much higher, giving rise to greatly reduced treatment times and the need for fractionation in many cases. The patient will undergo applicator removal surgery on the side ward or in the operating theatre. As the source exposure time will normally be of the order of 10 to 25 minutes, the nature of the care process and the required built environment, are unique to this form of therapy.

8.34 A single highly radioactive sealed source of Iridium 192 or Cobalt 60 is used. This is moved within the applicator to generate the required dose distribution within the tumour. In common with the other machine-based afterloading techniques, the source may be withdrawn under remote control to a safe within the machine.

8.35 The patient journey, like the care process, has important differences to the techniques described earlier. The patient will generally be taken to an operating theatre where the applicator will be inserted, implanted or placed under radiological control using a mobile or permanently installed image intensifier. Here the journey has two mutually exclusive options, the choice being dependent on the built environment design selected by the care team.

8.36 In the first option, the intermediate standard operating theatre is built with heavily shielded walls and have the facility to monitor the patient from an adjacent shielded area. The HDR machine is housed in the theatre and following the placement of the applicator within the patient the HDR machine is coupled and treatment may commence. This option works particularly well

where the applicator is, or may be, readily inserted and removed. The patient will return on subsequent days for the administration of further dose fractions as necessary. During treatment, all persons other than the patient must leave the treatment room which is then an exclusion area.

8.37 The second option is more conventional and involves the patient being taken from the operating theatre where the applicator(s) have been inserted to a separate treatment room. This may involve moving an anaesthetised patient, with the safety problems that are attendant to this action. Accordingly, it may be greatly desirable to position the facilities so as to ease and/or shorten this transfer. In some centres a Cobalt or linear accelerator treatment room may be used; others have constructed purpose-designed shielded rooms. The former choice reduces building and maintenance costs but interrupts the use of the teletherapy treatment equipment. The specially constructed room is free of these objections but may not offer great advantages in terms of cost and flexibility compared to the shielded intermediate operating theatre.

8.38 Regardless of the option selected above, the room in which the applicator is inserted must be large enough to support a surgical team in aseptic conditions and to allow the use of an image intensifier. Full anaesthetics and patient monitoring facilities will be required. Colour CCTV is needed to monitor anaesthetised patients during treatment.

8.39 The relevant regulations and codes of practice require that HDR treatment procedures are undertaken in relatively high radiation shielded areas incorporating the use of a small maze entrance.

Brachytherapy treatment planning

8.40 The majority of brachytherapy treatments will require careful planning in terms of treatment choice, dose used and dose distribution obtained from a given applicator position. This may entail an X-ray or other examination to show the location of the applicator in-situ.

8.41 A dedicated treatment planning system, connected to a network, will be needed in some instances while other technical choices will permit this function to be performed by a planning computer also used for teletherapy.

8.42 **Components of a radiotherapy suite**

- Treatment room and maze for use with linear accelerator;
- Linear accelerator control areas;
- Physics equipment store and laboratories;
- Pre-treatment interview room (radiotherapy);
- Information area and library;
- Brachytherapy source storage and preparation;
- Plant room for each linear accelerator.

8.43 See Appendix 2: Room layouts, for example layouts.

Chemotherapy

Chemotherapy treatment techniques and facilities

8.44 Chemotherapy involves the use of cytotoxic drugs either individually or in combinations to treat cancers. The drugs are usually given by the intravenous route, either as a bolus over minutes or an infusion over hours but may in some cases be taken orally as a tablet or capsule. In principle the drugs are toxic to both cancer cells and normal cells of the body. The treatment intent is to effectively poison the tumour cells whilst giving a dose to normal tissues that is low enough to assure the patient's survival.

8.45 Chemotherapy can be used to treat metastatic (secondary) and primary disease simultaneously and often is the treatment of choice in diffuse, non-focal disease.

8.46 In recent times, new drugs and methods have improved this treatment in terms of reduced patient suffering and morbidity. Selective administration of the drugs, using lines or catheters placed into the tumour or adjacent vascularity, can be helpful and is increasingly practised. The use of chemotherapy as part of the overall treatment strategy, which also involves hormone therapy, tumour suppressive drugs and radiotherapy, is a common and necessary practice.

8.47 Patient-specific fractionation treatment protocols will be adapted from standardised procedures to suit the type of tumour, proliferation rate stage, etc. One fraction may consist of a combination of drugs given over a period of one or two weeks, or two or more cytotoxic drugs administered over a period of one day. In essence, a cycle of chemotherapy drug administration is configured and prescribed before the course of chemotherapy treatment is commenced and then repeated until the entire prescription is completed or a cure is established. In some instances, where there is little or no response from the tumour, then the regime may be changed during or at the end of the initial treatment. The patient will be subject to regular imaging investigations and pathology tests to validate or otherwise the success of the treatment.

8.48 Treatment can take from two months to two years depending on the type of cancer.

8.49 The patients must have a blood test prior to treatment to determine the final composition of drugs and other clinical factors. This may take place at a GP surgery or local hospital up to 24 hours before treatment. When testing is conducted immediately prior to treatment there will be a waiting period of 30 minutes between taking the blood sample and the delivery of drugs, patients may wait in a waiting area or treatment area depending on throughput and care strategy.

8.50 The patient journey involves chemotherapy and associated care being given on a day-case basis or as an outpatient in the majority of cases. However, as chemotherapy may be used with those whose disease is at an advanced and debilitating stage, in-patient care may be needed. In the majority of cases patients will be mobile, although attached to a drip during the administration of the cytotoxic drugs.

8.51 For those patients receiving lines, e.g. Hickman system or drug administration catheters, the journey will involve a visit to a purpose-designed interventional radiology facility or standard operating theatre. The procedures are relatively minor and will have only a short recovery time though general anaesthetic is sometimes used. There is no express need for these facilities to be within the cancer care centre but such incorporation is often helpful in avoiding treatment delays and ensuring continuity of care.

8.52 Long term or 'stochastic' reactions can include stunted growth and development in older paediatric patients as the cytotoxic drugs inhibit thyroid function. The tight integration of other acute medical services is therefore vital to the overall care of the patient. In addition, it is known that certain cytotoxic drugs can have an effect on cardiac function and this needs to be monitored in at-risk patients during and after treatment. Baseline measurements of cardiac function are also required and for several drugs, measurements of renal functions are advised.

8.53 Hair loss as a result of the toxic effects of these drugs is a declining but still prevalent patient care issue. The use of 'cold caps' as a means of reducing hair loss is increasingly common though not always successful. The use of these caps requires the provision of storage facilities and a domestic refrigerator/freezer. For some patients the fitting of wigs will be necessary, though only a minority of facilities incorporate this service within the chemotherapy facilities.

8.54 Books, televisions, etc and other patient entertainment facilities should be a feature of chemotherapy day-care units and wards. Essentially, the patient remains on a treatment chair or couch for periods of 30 minutes to several hours. It is often beneficial if relatives, friends or hospital staff can remain with the patient and some units will give social care as an integral part of the treatment process. Commonly, day-care treatment rooms will accommodate six to 12 patients in an open area with good nursing observation. Typically such units will also incorporate side rooms or separated areas for those requiring treatment in more private circumstances.

8.55 The cytotoxic drugs will have a harmful effect on the patient's immune system. Greater emphasis must be placed on design to enable staff to keep the treatment unit, or ward, clean and as free from infection as is reasonably possible, while still providing a comfortable environment. Immediate reactions to the drugs may include nausea and vomiting, though this is less common with modern techniques. However, the room design should be such as to facilitate easy cleaning and decontamination.

8.56 Further to the above, patients occasionally have a more severe adverse reaction to the treatment. Nursing facilities must include oxygen and suction outlet in a group room plus an emergency box with full resuscitation facilities near at hand.

8.57 Chemotherapy facilities should include at least one area where a tuberculosis (TB) patient can be cared for as tumours may develop as a consequence or complication of this disease. Similar considerations may also need to be applied to the care of patients with HIV or AIDS without discriminating against them.

8.58 Access for people with disabilities to chemotherapy facilities should be regarded as essential.

8.59 Special equipment requirements within chemotherapy areas will be variable and should be subject to local consultation. However, the cytotoxic drugs are hazardous and regulatory requirements extend to secure storage in locked and alarmed facilities which will include the need for refrigeration in most instances. Facilities for manual or computerised record keeping are essential. Records must permit ready audit of cytotoxic drug use and administration to individual patients. In addition, patient-monitoring equipment must be available though occasional rather than routine use is expected.

Cytotoxic drug preparation, storage, transport and disposal

8.60 Pharmacy facilities, purpose-built or adapted, are required by regulation. Cytotoxic drugs for use in chemotherapy must be prepared in an aseptic pharmacy preparation room, this may be located in a main hospital or as a pharmacy outpost in the cancer care centre.

8.61 The nature of the facilities depends on the classification of the work done under the pharmaceutical regulations. This is concerned with the extent to which drugs are being manufactured or, more simply, prepared. In all cases, operator protection against toxic aerosols and surface contamination is an essential feature and implies the use of a controlled environment, housing containment and safety cabinets. Ease of decontamination is an essential feature and dictates the use of impermeable and smooth floors, walls and bench surfaces.

8.62 The discharge of cytotoxic materials into the environment is also regulated. Accordingly, specific routes for disposal must be agreed and described in local rules and protocols.

8.63 The suite will be designed to facilitate controlled access for those with appropriate authorisation only. The use of protective clothing is necessary and requires the provision of storage and modest changing facilities.

8.64 Cytotoxic drugs may be delivered by hand or by pneumatic tube, however the means of delivery must be secure and traceable.

8.65 **Components of a chemotherapy suite**

- Chemotherapy treatment room;
- Inpatient chemotherapy ward;
- Chemotherapy storage, use and disposal facilities;
- Chemotherapy pharmaceutical preparation laboratories.

8.66 See Appendix 2: Room layouts for example layouts.

9. Medical physics services

The role of medical physics

9.1 The provision of medical physics services or clinical science support is undoubtedly essential to the provision of a range of modern cancer care services, particularly in the area of radiotherapy. The following list illustrates the range of contributions which clinical scientists and medical physics technicians may be expected to provide:

- radiation protection advice and scientific support of safe ty provision;
- calibration and output monitoring facilities for devices which generate radiation beams, including linear accelerators, etc., used in teletherapy and also radioactive sources applied in brachytherapy;
- the provision of quality assurance services in both therapeutic and diagnostic facilities applied to cancer care;
- first line and, in some cases, more comprehensive services for the maintenance of cancer care equipment, particularly linear accelerators and radiotherapy simulators;
- the design and construction of accessory devices used in routine teletherapy such as shielding blocks and other modifying items;
- the provision of patient dosimetric services to include patient surface dose measurement by thermo luminescent dosimetry (TLD) and the use of radiation-sensitive diode arrays;
- clinical scientist and medical physics technicians have a learned role in terms of maintaining the scientific and technical standards of understanding within a department and also supporting the research endeavours of other professional groups;
- a role in the maintenance of good standards in respect of imaging, including the use of image computing and the development of such facilities;
- provision of scientific and technical support to the radiotherapy treatment planning process for both teletherapy and brachytherapy;
- a ‘troubleshooting’ role related to the correction of deficiencies in operational protocols and the routine functioning of radiotherapy departments and, in some instances, medical cancer facilities;
- installation and commissioning of major equipment.

Facilities required

9.2 The following rooms or facilities are needed to accommodate the long list of functions for medical physics above:

- the provision of offices suitable to accommodate administrative and academic functions and also for treatment planning;
- laboratory space with suitable benching and under-bench storage to permit the conduct of physical science experiments over a very broad range of objectives but to include instrument calibration and the development of bespoke devices;
- storage facilities for an extensive range of equipment including delicate instrumentation, dosimetry equipment, quality assurance devices and sundry materials used in mould rooms and engineering workshops;
- metal fabrication and general engineering workshops. The scale of these workshops will be dependent upon the technological choices made for the delivery of teletherapy services in particular, though the majority of departments also support a broader role.

9.3 Detailed guidance on these facilities is given in Chapter 16.

10. Facilities for the use of unsealed radioactive sources

Unsealed source therapy

10.1 Unsealed radioactive sources are simply radioactive materials present in a non-encapsulated form, normally implying a liquid solution, though gases, droplet suspensions and powders are also occasionally used. Rigorous care and attention to safety matters is always an important component in unsealed source use, storage and disposal. This care requirement and the use of strict protocols significantly influences cancer care centre design.

10.2 In clinical terms these materials may be used for both diagnostic and therapeutic applications. In both cases the underlying principle employs biochemical and physiological mechanisms of substance uptake. For example, the sugar glucose is taken up from blood and metabolised by the brain. If this sugar is 'labelled' by the attachment of a radioactive substance to form an injectable unsealed source then the brain may be imaged using the very low level radiation produced.

10.3 In therapeutic terms, the objective is clearly not to image but is instead to deliver a large radiation dose selectively to a tumour or cancerous tissue. The most commonly used example employs unsealed Iodine 131 to treat cancer of the thyroid gland by taking advantage of the natural uptake of iodine by that organ.

10.4 The availability of both diagnostic and therapeutic unsealed source related services are intrinsic to the care of cancer patients in a cancer care centre.

10.5 Cleanliness, and often sterility, are important in the medical use of unsealed sources. For substances given to the patient orally, for example the iodine drink or capsules referred to above, high standards of cleanliness are essential. For injectable (IV) materials, full pharmaceutical standards must be met such that aseptic and sterile considerations are to be respected.

10.6 Unsealed sources clearly emit ionising radiations and thus all the issues surrounding the shielding of the sources and environment apply equally here. However, for unsealed materials, an additional challenge is generated by the need to avoid spillage and to control the spread of radioactive contamination from such sources. These two requirements influence design significantly, both in terms of structure used and surface finishes applied. There are also important implications for material choice due to chemical considerations, for example the often irremovable nature of iodine contamination of stainless steel. The detailed advice of the local Radiation Protection Adviser (RPA) should be sought at an early stage.

10.7 The use of some, though not all, radioactive unsealed sources has a significant environmental influence.

10.8 A full background description and design advice on the diagnostic uses of unsealed radioactive sources is provided in NHSScotland guidance SHPN 06 'Facilities for diagnostic imaging and interventional radiology'.

The patient journey

10.9 The patient journey for those cancer patients receiving unsealed source therapy differs greatly from the general case. An outline description with notes on the built environment implications is given below:

- referral for unsealed source therapy will follow from diagnostic procedures and a meeting with the patient's responsible consultant, who may be from one of a number of disciplines;
- the patient will be admitted as an in-patient for the majority of treatments, most particularly for iodine treatment of the thyroid. This is necessary both for clinical safety reasons and owing to the need to control the potentially hazardous materials and radiation used;
- a side room with special facilities is needed to accommodate the patient during treatment. Key features include protection against both radiation and radioactive contamination;
- in the majority of instances, the unsealed source drink or capsule will be given to the patient in the side room to the treatment suite. This minimises the risk of contamination spread in the hospital and promotes patient-centered care;
- the administration of the substance will be given by a clinician often accompanied by a clinical scientist and nurse. Monitoring of the radiation level will be conducted for both safety and treatment control purposes with the patient in bed;
- the patient will remain confined to the treatment room until the radiation level drops below a defined threshold, after which transfer to the general ward or discharge will be considered. In older designs of treatment room the use of shadow-type protective shields alone implied that the patient must remain largely in the bed. However, modern designs give greater freedom and have en-suite facilities for the patient's use. This latter feature has the major advantage that radioactive urine and faeces are discharged by the soil drainage system, of special design, within the treatment room. Equally a washing machine, washing-up sink and washhand basin for use by staff play a useful role in preventing the spread of contamination;
- during the long period of confinement within the treatment room, good design and the use of shadow shields will permit the patient to have visitors on a limited basis, and afford the possibility of less minimal nursing. Some advanced designs also incorporate a window and use external shielding as a garden feature. Patient groups indicate that such features are helpful in

relieving the effect of treatment room stays of typically two to five days. Such solutions may require controls on outside access.

10.10 **Components of unsealed source rooms – therapy suite**

- iodine treatment room, en-suite facilities;
- storage facilities for unsealed radioactive materials;
- delivery facilities for unsealed radioactive materials;
- unsealed source preparation laboratory (materials are generally sourced from Radiopharmacies;
- contaminated items store; decay store;
- monitoring instruments store;
- storage facilities for spill kit;
- personnel decontamination facilities.

Care of the disabled

10.11 Generally within cancer care centres there is little or no reason why design elements should not be incorporated to permit access for the full range of disabled persons to all facilities, without compromise to general or specialist safety requirements. However, for wheelchair users a special problem is thought to exist so far as access and egress is concerned and in controlling contamination from iodine and similar treatments. This arises from the use of water bars at strategic points on the floor within the treatment room. These are required to contain any spills or other 'accidents' containing radioactivity. To date no fully effective solution to this challenge has been identified.

10.12 During the process of showering, washing or other body functions, excreted body fluids containing radioactivity pose a particular problem. Designs to restrict the spread of contamination at the entrance to the sanitary accommodation, and if possible at the entrance to the treatment room, are strongly recommended.

11. Cancer surgery requirements

Characteristics and applications of cancer surgery

11.1 Although radiotherapy, chemotherapy and hormonal work have all gained substantial ground in recent years, the majority of clinical referrals continue to be directed to cancer surgeons. This reflects the very high value of cancer surgery both in palliative work and radical curative applications. Although greatly variable across the UK, the majority of surgery will form part of an integrated treatment programme by making use of many parts of the portfolio described in this document.

11.2 The profile of cancer surgery continues to change markedly and is the subject of constant learned and advanced technological development. This is reflected in the increasing range of surgical techniques and broadening envelope of use as well as improved outcomes. The boundaries of surgical activity are less distinct than hitherto owing to the rise of minimal invasive therapies which may supplement or replace conventional surgical techniques.

11.3 As might be expected for surgery as a whole, the level of invasion and severity of procedures is broad. The following list, although not fully comprehensive, is representative of commonly applied techniques which must be supported by cancer care centres:

- laser ablation for the treatment of cervical pre-cancer and a range of other relatively accessible lesions;
- the removal of surface or skin lesions by conventional or cryosurgical means;
- cancer-related uses of endoscopy;
- the insertion of lines and catheters, including Hickman-type, by surgical or minimal invasive means, often under X-ray control;
- the insertion or implantation of brachytherapy applicators or tubes for machine controlled afterloading radiotherapy. Occasionally pre-loading of sealed radioactive sources in the operating theatre may still be required;
- breast surgery as a part of a comprehensive breast care service. This will range from relatively modest lumpectomy procedures to radical mastectomy, including the removal of lymph nodes. For the purposes of this guidance, the commonly applied technique of mammography guided needle biopsy is considered to be non-surgical;
- some centres will be offering surgery to the prostate, including robotic procedures, though not all such work is cancer-related;

- a broad category of investigative surgery continues in use. This area is in modest decline owing to the increasing contribution of cross-sectional imaging by CT and MRI;
- de-bulking of benign, and some forms of malignant, tumours. Such surgery can be radical in nature and is frequently a precursor to other forms of treatment;
- surgery with direct curative intent on largely nonmetastatic low-invasion tumours;
- *surgical biopsy*. This range of techniques continues to be very important as it permits the sampling of suspected cancer tissues for histological examinations which may confirm or deny the presence of malignancy. This area is developing quickly in technological terms owing to the increasingly common introduction of both stereotactic and navigational techniques. These technologies, which have their origins in neurosurgery, are now more broadly applied. Images from CT and MRI are used to enable this type of surgery;
- *reconstructive surgery*. There is a greatly increasing demand to reconstruct parts of the body that have been damaged by cancer or the processes of surgery. These procedures are particularly common in the breast and are increasingly seen as indicators of high-quality care;
- *intra-operative radiotherapy.* This is a technique which has begun to be used in the United States and could be expected to spread. A small source of ionising radiation is used in the operating theatre to treat an exposed tumour with associated radiation hazards. This will require at least some structural radiation shielding to be incorporated into the walls of the operating theatre, together with shadow-shielding. It may have implications also for the electrical supplies required to that theatre.

11.4 The above clearly represents an extensive portfolio of techniques which places a range of demands on operating theatre design and availability. In considering programmes to modernise cancer care centre provision, project teams should evaluate, at local level, the number of operating theatres and associated facilities required. The nature of such facilities is dealt with later in this guidance.

Outline classification of requirements

11.5 The range of surgical facilities needed to accommodate the above techniques is wide and variable in nature. In order to simplify planning and design challenges, this document uses a simple but arbitrary classification scheme. This scheme grades operating theatres from Levels 1 to 4 according to the protective requirements in terms of possible infection. In addition, three categories are used to indicate the extent to which the theatres concerned are standard, modified to suit cancer treatment or largely devoted to such treatment. These groups represent categories 1, 2 and 3 respectively, see Table 5.

11.6 The Chief Medical Officer advises continued and increased vigilance concerning the quality of the built environment used for the decontamination, sterilization and storage of surgical instruments. Mention of these facilities is made below, however, attention is drawn to the Property and Environment Forum's compendium of documents and advice published on CD-ROM.

Built environment requirements

11.7 The following provides an outline description of the requirements for cancer surgery using the categorisation described above. For general advice the reader is referred to NHS Estates guidance HBN 26 'Operating department' together with Scottish Hospital Planning Note 26 'Operating department.'

Facilities for relatively minor procedures

11.8 This environment is perceived as being appropriate for procedures where the risk of infection is relatively low and the period of immediate recovery short. As may be seen from Table 5, most of the surgery is to the skin or body orifices, though some simple biopsy work will be included. General advice on the largely similar 'treatment area' concept is given in NHS Estates guidance HBN 40 Volume 2 – 'Common activity spaces: treatment areas'.

11.9 The rooms broadly have the characteristics required for general minor procedures. Particular attention is drawn to the need for easy-to-clean surfaces, devoid of dust traps. The drive toward reduced infection rates puts particular emphasis on good quality clinical hand washing facilities. Some local teams may also require scrub-up facilities which may be located adjacent to, or in a corner of, the procedures room. A simple support suite for reception of patients, who will mostly be ambulatory, should be provided together with facilities to receive patients in wheelchairs or on trolleys.

11.10 Within the procedures room, basic medical gas supplies including air, oxygen and vacuum/suction will be needed, though general anaesthesia is not envisaged at this level. A low-power, ceiling-mounted operating light will be needed together with a single surgical pendant. The introduction of the pendant is now seen as an essential requirement in the interests of improved patient service arising from the greater dependence on technology use in these rooms. The need to eliminate or reduce hazards to staff from trailing cables has also been considered. Mechanical ventilation, using a coarse filtered air supply, will be required but the business of micropore filtration and accurate airflow control is not seen as a key requirement. The room shall incorporate facilities for cryosurgery where local demand can be demonstrated.

11.11 The suite should include a recovery room sufficient for two patients, storage facilities for lay-up of small surgical trolleys, drugs, etc., and a separate dirty storage room for the short-term accommodation of contaminated surgical equipment. The local decontamination and recycling of surgical equipment is not recommended.

11.12 Three options for the location of the cancer minor procedures facility should be considered:

Option one

Close to the outpatients department or facilities used for general cancer patient care.

Option two

As part of a theatre complex but located towards the periphery of the theatre grouping in a relatively patient-accessible location. This should be such as to ensure the absence of need for the patient to enter the clean theatre corridor other than under the full control of staff.

Option three

Adjacent to in-patient wards and other treatment areas.

Surgical technique	*Theatre level*	*Room category*
Laser ablation	2	2
Surface cryosurgery	1	2
Cancer endoscopy	1	2
Insertion of lines and catheters	2	2
Brachytherapy implants	2/3	1 (HDR 3)
Breast surgery	2/3	1
Prostate procedures	2/3	2
Investigative surgery	2/3	1
Tumour de-bulking	2/3	1
Curative surgery	3	1
	3/4	3
Reconstructive	4	1 (3)

Table 5: **Operating theatre facilities required for cancer surgery**

Facilities for intermediate level procedures

11.13 These may be characterised as operating theatres for full, but not especially prolonged, anaesthesia and incorporating a full operating table, surgery lamp(s), monitoring facilities and be of sufficient size to allow for a full operating team of six persons. Full scrub-up facilities adjacent to the operating room must be provided. The theatre shall be equipped with a full filtered air system with pressure and flow regulation but ultra clean facilities are not envisaged at this level.

11.14 The theatre suite shall incorporate a recovery room with full observation facilities, trolley lay-up or preparation room (clean supply), separate used trolley storage or, if local conditions allow, trolley breakdown room with adjacent decontamination facilities.

11.15 In order to promote efficient and safe operating theatre use, there is a clear requirement for a separate but adjacent anaesthetic and patient preparation room, equipped with full medical gases as for the theatre itself.

11.16 Some specific cancer specialisations present themselves in relation to facilities of this type. Where local treatment approach so requires, the insertion of brachytherapy applicators will be supplemented by facilities to permit high dose rate machine afterloading treatment. Such facilities are an observably effective option to the provision of treatment rooms specialised for HDR only. Where incorporated into operating facilities, HDR will require room shielding-based radiation protection and remote protected observation/control. Colour closed circuit TV (CCTV) will be needed for patient observation. The design of the facility should be such as to afford the anaesthetist an acceptable level of confidence while HDR procedures take place as the patient remains under anaesthetic.

11.17 Theatre type standard finishes and general facilities as described in NHS Estates guidance HBN 26 'Operating department' and Scottish Hospital Planning Note 26 'Operating department', are fully applicable but particular attention should be paid to the need for mobile C-arm or image intensifier access and use. Special storage facilities for Hickman lines, catheters, guide wires, etc., will be needed. These should be within or immediately adjacent to the operating room.

11.18 Where cervical and other Class 3 laser treatment procedures are to be offered, the special considerations, set out by the Medical Devices Agencyguidance, must be followed. This will include special power supplies for laser equipment, reduced or non use of polished surfaces and the provision of window blinds, laser safety signs, etc. The laser radiation protection advisor (LRPA) must be consulted on theatre design, the declaration of a laser controlled area and the provision of warning lights, etc.

11.19 Options are readily identified in terms of the provision of this facility:

Option one

A location adjacent to other cancer inpatient facilities as a satellite of the main hospital operating theatres.

Option two

This option entails that the theatre simply be a part of the hospital's main theatre unit. This may pose a special challenge if HDR facilities are incorporated and the theatres are above the ground floor. This difficulty arises from the need for heavy radiation protection shielding and its consequent structural loading.

Locations adjacent to radiotherapy facilities are seen as undesirable owing to the need for full theatre conditions and possible out of hours use.

11.20 Although this group of facilities may be reasonably seen as little more than a limited modification of general operating theatre design concepts, a thorough consultation with the broad cancer care team is recommended at an early stage in design. Particular care should be paid to engineering requirements and energy use in these theatres. Further advice is provided in Appendix 1: 'Specialist engineering requirements'.

Facilities for high level procedures

11.21 A proportion of cancer surgery requires a longer period of anaesthesia and particular care over protection against infection. This being the case, access to a large area, high category operating facility will be necessary for the majority of cancer care centre teams. The provision of dedicated facilities will be needed only where local treatment programmes and specialisations are required. Thorough consultation with cancer surgeons and their support teams is essential.

11.22 The procedures conducted at this high level are of increased complexity and make use of additional technologies and may require further members of staff when compared to the less elaborate procedures accommodated by the facilities described above.

11.23 Complex organ surgery, which may encompass vascular aspects, and relatively new techniques that use stereotactic or navigational technologies are included within this area of activity. Some will be based on and applied in neurosurgery. Of these, the image-based navigation approach is developing quickly and requires that image data derived from pre-operative imaging, or alternatively imaging during procedures, be utilised. In the first instance, the images are transferred by disk or network to a navigation computer which must be accommodated within the operating room. These machines are relatively bulky and are associated with special cameras that also have to be accommodated, which track the position of surgical instruments within the patient's anatomy. Such surgery was originally confined to brain and spine but is now finding increasing applications over a broader range of anatomy.

11.24 Reconstructive surgery provides further examples of surgical tasks that are subject to the need for particular care in order to avoid patient infection. This gives rise to careful detailed design to reduce dirt and dust traps. Further, the standard filtered mechanical ventilation system, typical of the operating theatres described under intermediate level procedures, will require a higher standard. Attention to the use of micropore filtration to further reduce particles and quantity is appropriate. Systems are further augmented by the use of precision theatre room atmosphere pressure control and ventilation portals. These will require detailed engineering consultation. Further information is provided under 'ultra-clean ventilation' in NHS Estates guidance HBN 26 'Operating department' together with SHPN 26 'Operating Department'.

11.25 The use of overhead service pendants is required and care should be taken both in the numbers selected and their position relative to the operating table, surgical lamps and any plenum canopy used with the ultra-clean air system.

The use of navigational computers and some other surgical aids will require that power and other services be provided to computer/instruments systems. This is frequently best achieved by the use of a pendant partly or wholly devoted to this purpose. While all operating system power supplies will be connected to hospital back-up or generator systems, the use of an uninterruptible power supply (UPS) will frequently be necessary in order to safeguard proper operation of some of these computerised instruments.

11.26 Operating microscopes are worthy of particular attention in terms of the power supply considerations mentioned above, and also because of the exceptional bulk of some examples. These instruments, particularly in robotic form, are especially space consuming, being approximately two metres deep and requiring a lateral movement of one and a half metres. This space must be free of obstruction. Similar considerations may be expected to apply in future to other forms of robotic surgery and telesurgical technologies. Extending these considerations, the optical devices mentioned have a particular sensitivity to mechanical vibration which may influence decisions in terms of theatre siting and some elements of construction.

11.27 Storage facilities associated with operating theatres used for the specialised applications mentioned above will need to be larger than is otherwise contemporary and subject to special considerations on positioning so as to ease the movement of equipment. As this equipment will require frequent maintenance, the storage facilities or alternative areas should be sized so as to permit access by one or two service engineers. The provision of task lighting arrangement and power supplies to support this activity should also be considered.

11.28 The need for specialist decontamination of electronic surgical instruments should be evaluated. Many of these are unsuitable for conventional steam load porous sterilization.

11.29 The use of imaging technology and the specialist nature of some of the cancer-related surgery will place additional requirements on design in terms of data communication and teaching facilities. Theatres at this level must be equipped with a wide-bandwidth optical LAN to support image and general data communication to reduce the risk of interference from Rf-generating surgical instruments such as bi-polar forceps. Observation of procedures by staff and students in training is likely to be a frequent requirement. Consideration should be given to the possibility of elevated viewing windows or the lower cost alternative of CCTV systems.

11.30 The long periods of time spent by surgical teams, particularly the leading surgeon and their assisting nurse, give rise to a need for careful consideration of ergonomics, some aspects of lighting and the possibility of eyestrain. At the current state of understanding NHSScotland is not able to prescribe design solutions, but asks design teams to discuss these issues at local level with the staff concerned.

11.31 The siting of this category of operating room is essentially restricted to the principal theatre complex of the host hospital. It is important that the theatre has full local access to auxiliary accommodation and postoperative patient care facilities.

12. Offices and support facilities

Introduction

12.1 In general terms the office and general accommodation of a cancer care centre does not differ greatly from that of other hospital-based facilities of comparable size. However, a number of points requiring special care do arise.

Offices

12.2 Consultation rooms used for sensitive discussions with seriously ill patients and their relatives require careful siting. There is a need for discretion in terms of sound control, use of induction loop hearing aids, and of access and departure arrangements.

12.3 As part of the business of advancing cancer services, the great majority of centres are engaged in a range of clinical trials. These have special office needs to accommodate staff with roles such as record keeping and data analysis.

12.4 The National Cancer Registry is an intrinsic part of the drive towards better cancer outcomes and, as with clinical trials, there may be a need for temporary or permanent accommodation for a high-level clerical team.

12.5 The introduction of new technologies which better combine and handle patient treatment data, particularly in radiotherapy, has given rise to the need for data entry and review facilities for use by radiographers and other key treatment delivery staff. These can be accommodated in an open plan office suite adjacent to the radiotherapy facilities.

12.6 Office accommodation for those responsible for psychological and social care of patients and their families will be required, and open access rooms for patient information services are necessary.

Educational facilities

12.7 The widespread increase in the sophistication of approach to cancer care and the near-ubiquitous need for continuous professional development (CPD) has placed an increasing emphasis on education facilities. Key points in relation to cancer care centres include:

- the clear need for a seminar or lecture room with modern audio-visual facilities and good computer systems access, this is now well established. In order to promote effective use this should be located close to patient care areas. In the future, the seminar room will probably be the location of the

main telemedicine 'node' within the cancer care centre, therefore space and service provision should be made for this equipment;

- library facilities and Internet access points, these are key to modern cancer care services. It is essential to consider providing private study space. Remotely located facilities have been shown to exhibit poor level of uptake and use. Convenient staff access is accordingly an important parameter;
- specialist staff training facilities for the basic and postgraduate education of staff members such as radiographers, physiotherapists, etc. Design details are not within the scope of this guidance.

13. Information system requirements – image, pathology and radiotherapy data; computerised management of cancer care processes

13.1 The range of data types that must be used in cancer care is very large. It is recommended to bring together multi-disciplinary teams, and use a broad range of equipment, to optimise the treatment of patients and also to ensure that the treatment deals with the whole patient and not merely some aspect of their disease. Intrinsically, this requires that disparate data be brought together in a coherent way to generate clear clinical information.

13.2 In some traditional radiotherapy and cancer care centres within the NHS, the whole information process can be dealt with on film and paper since methodologies exist and very large spaces are available for storage.

13.3 In new and reconfigured cancer care centres, the feasibility of maintaining complex records on hard copy file materials is thought to be dubious. A move away from paper and hard copy materials is likely to be appropriate in some established centres from an economic and operational viewpoint. However, there is a substantial impact on building design when paper storage spaces are replaced by IT facilities.

13.4 In light of the above, the use of comprehensive computerisation at new centres is one preferred option and is in keeping with a trend in that direction by other major NHS centres. Consequently, distributive robust networks of multiple computer workstation servers is needed and this should be reflected in the building design. Suitable rooms should be allocated in which these servers and the associated network hub units can be placed. Network structures should be incorporated into service ducts, etc. Data entry and review rooms are also needed.

13.5 The multi-disciplinary nature of the work in cancer care requires that most , if not all, the services presently offered by the hospital remain but that they become intimately associated, where necessary, with new services provided. This being the case, any network used must have close ties to any network within the host hospital itself. Furthermore, if the hospital network is of relatively modest bandwidth, some upgrades within the hospital will undoubtedly be necessary.

13.6 The Royal College of Radiologists and a number of other learned bodies have drawn to the attention of the medical community the critical nature of delays, interruptions and errors in chemotherapy and radiotherapy treatments. This being the case, it is important that data is secured, not only against intrusion, but also against loss. Interruptions in or the inability to transmit data from places of storage to places of use may also be detrimental to patient service quality. Accordingly, if a digital option is to be pursued, a backbone network with

extensive route duplication and dual connection of servers and other critical devices appears to be necessary.

13.7 If the option above is to be pursued, the operational and design consequences should be carefully considered when developing or adapting a cancer care centre.

13.8 Changes in the way information is handled will have a great effect on the patient's cancer journey, and treatment schedule, when compared to traditional film and paper methodologies. In particular, reduced waiting times and more rapid throughput have been observed in radiotherapy departments modernised in this way.

13.9 The computer-based option may also free up some space used previously by large storage and film libraries. However, some of this space may be taken up by servers and other computer equipment as mentioned above. There may also be a need to store some data media in more than one building in order to protect against loss in the event of fire.

13.10 The computerised option will allow centres to communicate with cancer care units and primary care practices using telemedical means. This will almost certainly have an effect on patient journeys throughout cancer treatment by easily allowing some routine monitoring and follow-up to be carried out at local cancer care units and at primary care level.

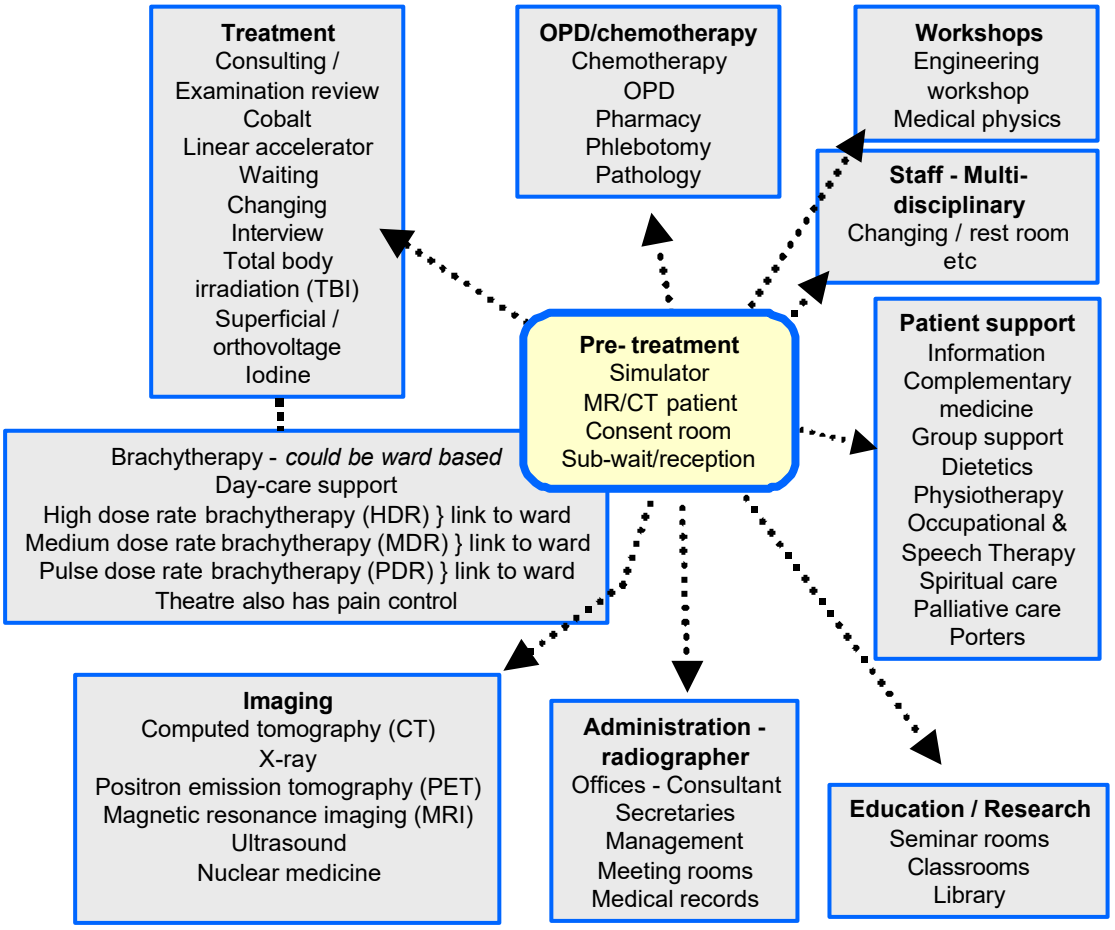
14. Description of accommodation

Introduction

14.1 This Chapter gives detailed guidance on the planning and design of accommodation in a cancer care centre and it:

- outlines the planning process;
- gives a detailed description of room requirements in diagnostic, treatment and support areas;
- highlights general design considerations.

14.2 Details of activities, equipment, environmental conditions and finishes are given in NHS Estates Activity DataBase. Detailed schedules of accommodation will be published in a separate document that will include cardiac and diagnostic imaging data.



Relationship between clinical functions and rooms or facilities used.

The planning process

14.3 Throughout this guidance, detailed attention is paid to safety, risk control and the implications for building design. The requirement to give such attention to building projects is embraced in SI 1994 No 3140 The Construction (Design and Management) Regulations. These are broad-based but ascribe particular and specific duties to both designers and others who contribute to the shaping of design solutions. The regulations were subject to technical amendment in 2000 with a clarification on the statutory definition of a designer.

14.4 The primary duty is for due regard to health and safety in design work. This includes a requirement to conduct risk assessments both in respect of the building and the process of its construction. In addition to an overall consideration of broad risk categories, the regulations also instruct on the need for safety and risk analysis at the detailed design level. There is a requirement to evaluate design options in terms of risk reduction and the cost of such, though a balanced approach with due consideration of many other factors is described as appropriate.

14.5 A large part of the design process must always consist of close collaboration and consultation with end users of the new development and those responsible for existing buildings within the same or closely related institutions. The regulations may be interpreted as requiring broad care in respect of overall design and facilities management as well as technical alignment. There is a particular need to avoid solutions that may be technically acceptable but not compatible with organisational and operational requirements.

14.6 In all instances there are duties for the designer and planning supervisor but those of the client or end user must also be respected. This will often require close co-operation and collaboration between employers including all participant parties in private finance initiative (PFI) and public private partnership (PPP) agreements.

Description of accommodation

14.7 These descriptions below cover the full range of built environments that may be used by cancer care centre patients, related healthcare professionals, support group members and relatives.

14.8 Some aspects of the accommodation described will be largely or wholly devoted to the care of cancer patients while other spaces will be of only limited relevance. This guidance covers the dedicated accommodation in detail but also describes any cancer-related specialisation or adaptation to more general rooms.

14.9 The full design details for the standard rooms are given in other NHSScotland and NHS Estates publications.

Common spaces

Main entrance

14.10 Ambulances and taxis may deliver and/or collect patients. The entrance canopy should be large enough to afford adequate weather protection for patients alighting from and entering vehicles, and high enough to clear lights and aerials on ambulances. The space should be well lit and suitable for use by those with disabilities.

14.11 Access to and from the main entrance should be through a draught lobby with automatic doors. The lobby should be large enough to allow people to stand aside to permit the passage of a patient accompanied by an escort and also to allow pushchairs and wheelchairs to pass. Consideration should be given to providing a smoking facility in order to avoid people congregating outside the main entrance.

14.12 For further information refer to:

NHS Estates guidance 'The design of hospital main entrances (Design Guide)' which can be used with general caution in Scotland.

NHSScotland and NHS Estates guidance SHPN/HBN 40 – 'Common activity spaces' Vols 1 to 5.

14.13 Attention is drawn to the need for the installation of induction loops for those with hearing difficulties.

14.14 The main entrance will be the principal route in and out of the centre for the majority of visitors and staff.

Reception and waiting areas

14.15 The reception and waiting areas will be the first point of contact for patients and carers when they visit the facility. It is important not to miss the opportunity to provide a reception that warmly greets all those who enter with a feeling of support and reassurance balanced with a sense of efficiency. A well considered reception with friendly staff and well managed appointments will help to reduce stress to both patients and staff. The benefits available from good interior and environmental design have been well researched and documented.

The influence of information technology

14.16 Conventionally equipped and managed treatment facilities and appointment systems generate waiting areas well represented in the NHSScotland and NHS Estates guidance referred to above. However, centres with fully integrated, computer-managed equipment and appointment systems and a well designed patient flow pattern with sub-waiting areas, are likely to result in smaller waiting areas whose character is calmer, less stressful and more humane. Reduced waiting times benefit the patient and promote a more efficient and relaxing

environment. Good examples of this arrangement are at Derriford Hospital near Plymouth and at the Karolinska Institute in Stockholm, Sweden.

Lounge/reception area at the Linda Jackson Macmillan Centre

Reception for chemotherapy waiting area. Note low desk section for talking to those in wheelchairs

Diagnostic facilities

14.17 The diagnosis processes will involve the use of one or more of the following departments. Depending on the circumstances of the cancer care centre these may be located in an adjacent building if the unit is part of a hospital, or the patient may have to visit a remote facility.

Radiology

14.18 In the cancer care environment, the purpose of a radiology department is to provide a range of facilities for the investigation of patients by means of radiological and complementary techniques. Investigations and procedures are selected by an oncologist supervising the patient's care in consultation with a radiologist. Radiology departments carry out investigations and report on the results as quickly as is reasonably practicable.

14.19 For further information refer to NHSScotland guidance SHPN 06 'Facilities for diagnostic imaging and interventional radiology'.

Haematology

14.20 Haematology is the study of blood, its function and disorders. Refer to NHSScotland guidance Scottish Hospital Planning Note 15 – 'Accommodation for pathology services'.

Consulting rooms

14.21 These will be used for consultation, examination, taking and recording of blood pressure, and for minor diagnostic and treatment procedures. Space is needed for a desk and chairs, and an examination couch, screened by curtains. There should be sufficient space within the curtained area for a patient to undress/dress in privacy, with assistance when required. The examination couch should be accessible from both sides. Space is needed for storing small items of equipment and small quantities of supplies and for a mobile adjustable examination lamp. Clinical hand wash facilities are required.

14.22 Consulting rooms should be large enough to accommodate a multi-disciplinary medical team as well as the patient, who may be in a wheelchair, and an escort. This will allow an integrated and balanced consultation to be delivered when appropriate.

14.23 The layout of the room should allow patient and consultant to be seated facing each other in an informal arrangement without any intervening barrier such as a desk, and should ensure maximum privacy, especially when the door is opened. Communicating doors between adjacent consulting rooms may facilitate the movement of staff, but they are not recommended as their use intrudes upon both the patient's privacy and the consultation.

Computed tomography (CT) suites

14.24 The scanning process involves the use of equipment that generates X-rays and therefore takes place in a room that is constructed from radiation shielding materials placed between adjacent rooms including the control room associated with the CT scanner.

14.25 Audio-visual contact with the patient during the scan is maintained through a protective glass screen supplemented by CCTV and intercom.

Magnetic resonance imaging (MRI) facilities: whole and part-body

14.26 The scanning process takes place in a room that is constructed from normal building materials but which is surrounded by a bonded wire screen to protect adjacent equipment from the strong magnetic field that is generated by the MRI unit.

14.27 Audio-visual contact with the patient during the scan is maintained through a protective glass screen supplemented by CCTV and intercom.

14.28 For further information see NHSScotland guidance Scottish Health Guidance Note 'Magnetic resonance imaging'.

Cytology laboratories and cervical screening

14.29 Cytology screening, particularly in respect of cervical cancer, constitutes a major established programme within the overall strategy for cancer care across the UK. The practice is to utilise microscope-based observations of cells or tissue samples obtained by the use of a speculum to scrape material directly from the cervical anatomy. There is no suggestion that these laboratories should only be in cancer care centres.

14.30 The process is vulnerable to error and in consequence, subject to very rigorous quality control. Audit measures are applied at every stage.

Accommodation and design

14.31 The cytology screening room is a dedicated cancer facility. The room will differ fundamentally in character from general pathology laboratories because of its special role and the very great need for care in ergonomic design. The walls should be finished in anti-glare neutral colours much as for the benches. The floors will be carpeted in heavy-duty material again with similar attention to the colour, carpet is used in order to suppress sound and also to soften the general characteristics of the room. Ceiling design should incorporate sealed light fittings and be constructed to minimise dust traps. The infection control team should always be consulted on finishes in clinical areas.

14.32 Some temporary storage of microscope slides, as well as auxiliary equipment, will be needed within the room.

14.33 It will be necessary to accommodate PC or similar computer equipment for access to pathology record systems and, in some instances, dedicated cytology screening records.

14.34 Windows should be largely restricted to those required to permit relaxation of the eyes by focusing on the outside horizon. Overhead natural daylight is unhelpful.

14.35 There are no special privacy considerations but full laboratory security measures are necessary. Access to the room will be restricted to professionals and auxiliary staff only. No patient access or access for relatives is required.

14.36 Professionals carrying out cytology screening may be disabled, and access and accommodation for the disabled, including wheelchair users, is an appropriate consideration.

14.37 The use of pendant-type service installations above some benches should be considered. This feature is particularly helpful over the height-adjustable island benches used for teaching, training and review as described earlier.

Information requirements

14.38 The keeping of records, both on paper and computer, is an important function.

14.39 For information on pathology facilities, many of which may be used as a part of the cancer care process, the reader should refer to NHSScotland's guidance Scottish Hospital Planning Note 15 'Accommodation for pathology services'. Information on the fitting out of laboratories is given in NHS Estates guidance HTM 67 'Laboratory fitting out systems'.

Therapeutic facilities

Nurse practitioner accommodation

14.40 A room of broadly clinical character and surfaces should be selected to promote easy decontamination and to reduce the risk of cross-infection.

14.41 Good standards of lighting with variable light level and a modest examination lamp, which may be either floor standing or ceiling suspended by an articulated arm, is suitable to permit the examination of surface anatomy or natural body orifices.

14.42 The room will contain an examination couch in an area that may be curtained off or otherwise separated from the remainder of the accommodation. Within the couch area, basic monitoring facilities to include those necessary for blood pressure measurement shall be included. Facilities for phlebotomy and the collection of readily accessible tissue samples are also required.

14.43 The examination or couch part of the accommodation must be large enough to accommodate the nurse practitioner and at least two other healthcare professionals as well as the patient.

14.44 In view of the potential for unpleasant odours arising from the procedures undertaken, the use of simple mechanical ventilation is required, 20–30 air changes per hour to allow for heated make-up fresh air. More complete mechanical air handling may be considered desirable where this is compatible with overall building design.

14.45 A consulting area in which the nurse practitioner may sit comfortably with the patient and up to two relatives should be provided. This should be of a relatively domestic character and the provision of coffee table and soft furnishings should be considered. The intention is to generate an environment where difficult issues can be discussed without undue formality. The nurse practitioner will require the use of a standard desk to be equipped with a personal computer suitably interfaced both to a LAN and through that to a WAN as required for communication with other medical sources including a local cancer care unit. The location of the desk and space afforded around it should be such as to permit small conferences with up to two other healthcare professionals in a relatively formal setting.

14.46 The nurse practitioner accommodation shall take the form of a fully enclosed room and access for patients by a light control or an enunciator system will be needed. It is also important that personal safety and security considerations in respect of the healthcare professionals utilising the room are considered. The fitting of an alarm button and use of CCTV are appropriate.

14.47 Nurse practitioner accommodation shall be positioned so as to permit easy access from the patient waiting area(s) and to other clinical consultation rooms used by GPs, etc.

14.48 A small refrigerator will be needed for the storage of body fluids, etc. A small lockable cupboard complying with the appropriate regulations for the storage of prescription drugs will be needed.

14.49 Filing cabinets and other means for the storage of paper records will be needed, though the requirements in this area are likely to decline as progress with the electronic patient record (EPR) advances at primary care level.

Minor procedures room

14.50 A room of clinical character and surfaces selected to promote easy decontamination and to reduce the risk of cross-infection is required.

14.51 Patients may be brought to the room on a bed or a trolley, in a wheelchair or on foot: members of staff and an escort will possibly accompany them. The door should be wide enough to permit easy access. Door swings should not impede movement or activities within the room.

14.52 Procedures may be carried out by doctors, nurses and appropriate other staff, with the patient lying on a bed, a trolley or an examination couch; sitting in a wheelchair or a chair; or standing. Access is required to all sides of a patient.

The examination couch should be mobile so that it can be moved easily to allow access to patients who need to be treated on a bed or a trolley.

14.53 The treatment room should be equipped with outlets for oxygen, vacuum, an X-ray viewing facility and a mobile examination lamp.

14.54 A preparation area is required where sterile packs, lotions and drugs for immediate use are stored and prepared for use, and where trolleys can be prepared for use and/or held. The preparation area should be separated from the procedures room by means of a partition wall, with the preparation area interfacing the standard treatment room and circulation space from which entry is made. Emergency call points, and clinical hand wash facilities are also required.

14.55 Clinical-quality colour-rendering light sources should be provided and walls, ceilings and floors should be of suitable colour and reflectance. The room should be sound attenuated. Natural light is preferred but not essential. Mechanical ventilation should be provided.

Endoscopy unit

14.56 Endoscopy is a general term relating to examination of a body passage or organ by means of an endoscope for purposes of diagnosis or treatment. Sophisticated diagnostic imaging may be employed where appropriate.

14.57 Further information and guidance including unit schedules of accommodation and room relationships are contained in NHSScotland guidance Scottish Health Planning Note 52 'Accommodation for day care – Part 2: Endoscopy unit'.

Nuclear medicine

14.58 The broad range of facilities including storage of radioactive waste is addressed in NHSScotland guidance Scottish Health Planning Note 06 'Facilities for diagnostic imaging and interventional radiology'.

Chemotherapy treatment rooms

14.59 A preparation area is required where sterile packs, lotions and drugs for immediate use are stored and prepared for use, and where trolleys can be prepared for use and/or held. The preparation area should be separated from the standard treatment room by means of a partition wall, with the preparation area interfacing the standard treatment room and circulation space from which entry is made.

14.60 The standard treatment room should have easy access from the consulting room(s) and bedrooms and be positioned between the clean and dirty utility rooms, with direct access for staff to each from the preparation area. A fridge should be available for scalp coolers.

Facilities for cancer surgery (special aspects of operating theatre suites)

14.61 The volume of cancer-related surgery cases generated will not normally justify a dedicated theatre suite, however good links with a general operating facility are essential. The theatre facilities do not generally differ in character from other theatre facilities, for example, laser equipment will be needed in some cases, techniques that are commonly found in gynaecological surgery.

14.62 Consultation with the laser protection advisor (LPA) at an early stage of the design process will identify operational, safety, engineering and built environment issues.

In-patient wards and related accommodation

14.63 Refer to NHSScotland guidance Scottish Health Planning Note 04 'In-patient accommodation: options for choice'. The general character will not differ from that of normal ward accommodation. However, a number of areas are different and will significantly affect the design. So far as is reasonably practicable, in accordance with the Scottish Executive's publication 'Our National Health – A plan for action, a plan for change', consideration should be given to the provision of patient *bedside* television/telephone/radio facilities; for further advice contact the NHSScotland Property and Environment Forum Executive.

14.64 Consultation early in the design process that relates to these areas is recommended in order to understand fully the implications for engineering services and the built environment.

14.65 Special side wards will be needed for those receiving treatment with sealed radioactive sources. These consist of en-suite single bed accommodation. The enclosing structure is shielded to prevent radiation passing from the room into the surrounding areas and typically consists of concrete in the order of 500mm thick with shielding doors and sophisticated electronic patient monitoring (see Appendix 2: Room layouts). For treatment with unsealed radioactive sources, the shielding does not require to be so thick. The concrete only requires to be between 100mm and 200mm thick (see Figure 2 and Appendix 2: Room layouts).

The RPA should always be consulted early in the design stage when those areas are being considered.

Radiotherapy reception

14.66 A well-considered reception with friendly staff and well-managed appointments will help to reduce stress to both patients and staff. The benefits available from good interior and environmental design have been well researched and are documented. For further information refer to NHS Estates guidance Design Guide 'The design of hospital main entrances' , and Health Building Note/Scottish Hospital Planning Note 40 'Common activity spaces', Vols 1 to 5.

General design considerations

14.67 Reception desk design should balance the need to provide adequate data protection of appointment workstations and low sections of counter for exchange with patients in wheelchairs.

14.68 Reception counters will need to accommodate a number of workstations that will vary from facility to facility, the number depends on areas served, network point/s and printer. They should also afford adequate clerical desktop workspace and cupboard space for stationery, etc.

14.69 The waiting area, entrances and exit points should be visible from the reception desk.

14.70 Good wayfinding is essential to help reduce stress to both patients and staff and contribute to a calm well-organised atmosphere. For further information refer to NHSScotland Property and Environment Forums guidance 'Wayfinding'.

14.71 Sub-reception points should be near to entrance routes and near to treatment rooms. One sub-reception point is required per two linear accelerator treatment rooms or simulators.

Radiation therapy facilities (radiotherapy)

Patient changing facilities

14.72 Wherever possible, changing facilities should be adjacent to the treatment/planning facility and positioned so that patients cannot be seen by others once they have changed.

14.73 To assist with effective throughput, a minimum of two changing rooms per facility are required. One should be of sufficient size to permit changing for the disabled. Ideally, there should be a two-door arrangement where the patient enters the changing room from the waiting area, changes then exits into the treatment room/maze.

Treatment room

14.74 The dominating nature of a linear accelerator and the mass of high-tech equipment are likely to present a daunting experience for patients, which may be further exacerbated by equipment haphazardly placed around the room, often due to the lack of adequate storage space. Therefore every opportunity should be taken with the interior design to minimise these effects. The aim should be to create comfortable and cheerful surroundings with a sense of order and reassurance.

14.75 Lighting will play an important role. It will need to vary from subtle, for patient relaxation; low level when using laser alignment light; to normal levels for routine access and duties and high levels for maintenance tasks. The room should also have a 2-way sound system to lessen the patient's feeling of isolation during treatment.

Maze

14.76 The maze, the entrance and entry into the treatment room, must allow access for the treatment machine and subsequent replacement equipment. It should be wide enough to admit a hospital bed with additional equipment, trolleys, wheelchairs and large heavy components for linear accelerators. Corner/wall protection against damage by equipment wheelchairs, stretchers, beds, etc, should be provided. In certain circumstances the equipment may be delivered through 'access' openings which are then completed and filled in as necessary.

14.77 If there is a particularly long maze, consideration should be given to having a fold-down seat for more infirm patients.

14.78 Access control gates and/or infra red beams must be provided.

14.79 Lighting should be subtle and not glaring.

Engineering services

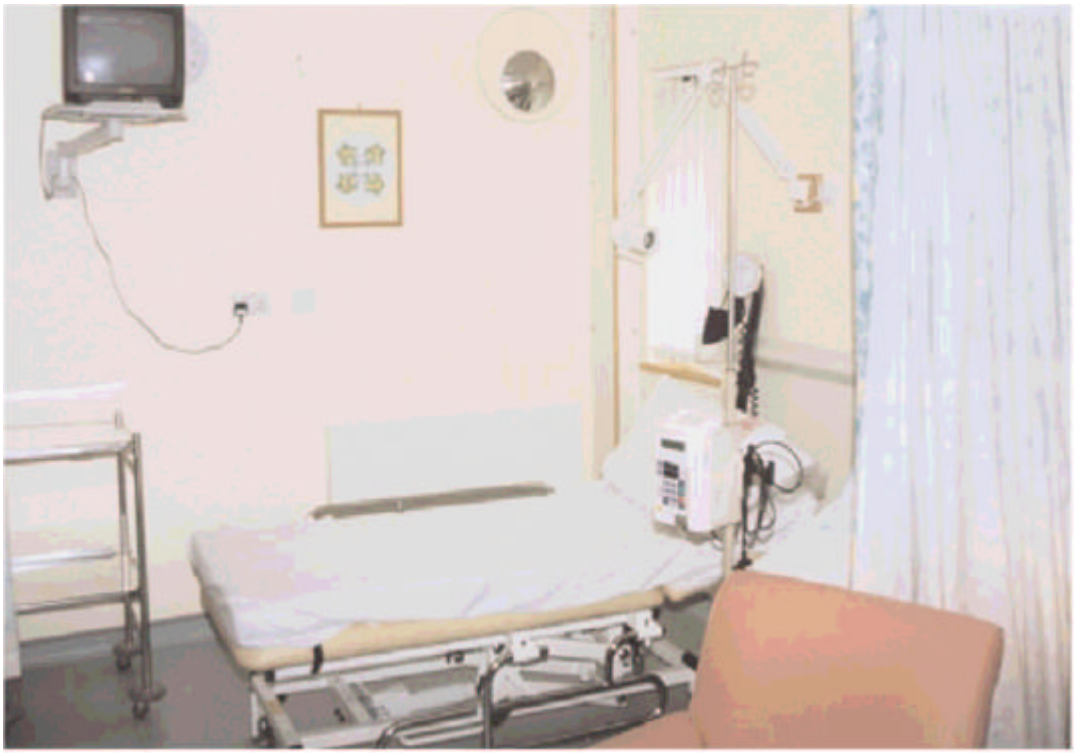
14.80 The usual way for environmental services to gain access to the shielded treatment area is by way of the ceiling void of the maze. The effectiveness of the shielding in the maze is often increased by concrete downstand baffles. These overlap to stop the direct path of radiation but are offset from each other and positioned in such a way as to allow services to weave through the chicane of concrete baffles.

Linear accelerator treatment room (general purpose)

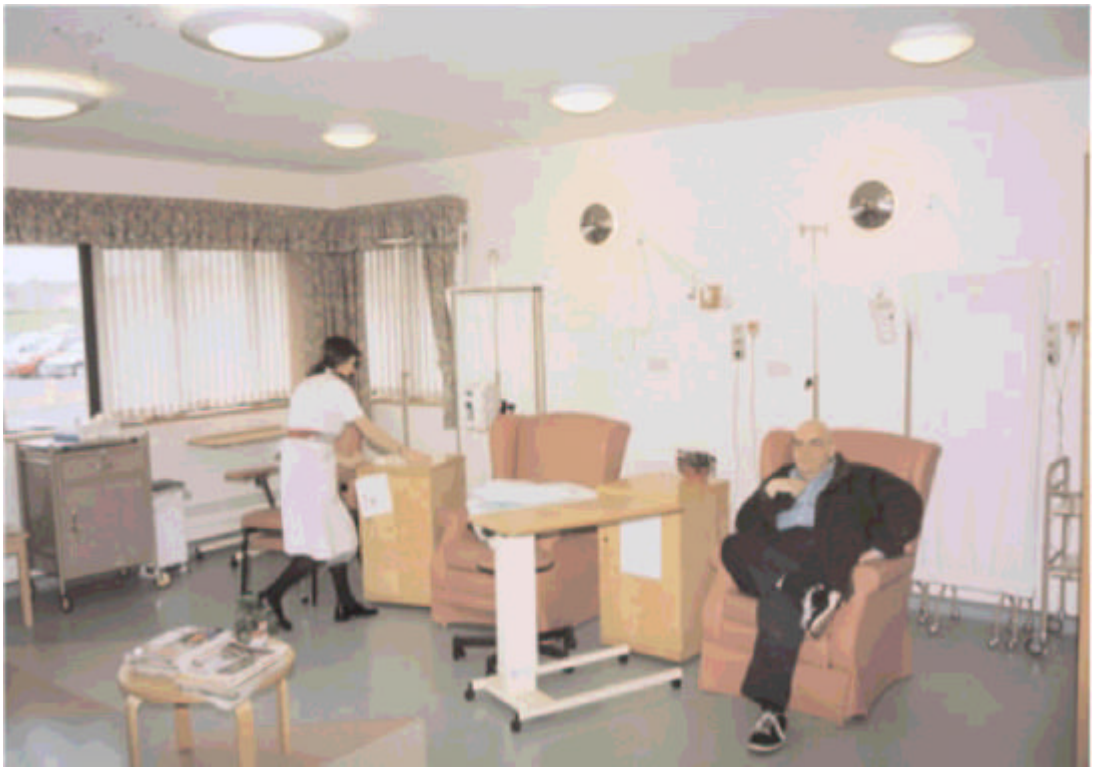
14.81 This room must be easily accessible from changing cubicles and sub-waiting areas.

14.82 The size of this room is critical, there must be enough room for storage of equipment and easy access, enough space for easy movement around the room and space for patients on beds, trolleys and wheelchairs. The open shelving seen in this photograph may not be suitable everywhere on hygiene grounds.

14.83 For total body irradiation treatment, consideration must be given to the positioning of the treatment unit within the room to ensure the adequate distance is achieved between the treatment unit and the patient couch. The couch is usually placed against the wall, i.e. the treatment unit is often found off-centre in the room to achieve this relationship.



Single patient treatment couch in a chemotherapy department used where patient privacy is needed



Chemotherapy treatment area

Linear accelerator treatment room showing customised storage facility

14.84 The trenches and floor chases required for hidden cables and support frames will be extensive and will vary from one manufacturer to another. It may be possible to establish through consultation with manufacturers and specialist agencies the extent and critical dimensions of these features. It is essential that this information is available to the design team at an early enough point in the design programme to allow these features to be incorporated into the drawings used for the construction of the concrete shielding structure or treatment room.

14.85 A floor trench between the wall of the treatment room and control area is needed to gather all services passing between control area and treatment machine.

14.86 A duct passes between the floor trench and a similar trench in the control area. The trench and ducts must not compromise the radiation shielding offered by the shielding walls or floor in the case of a treatment room with radiation sensitive areas beneath. A separate duct is required for dosimetry cables to allow the cables to take the shortest route from machine to control desk.

14.87 Recess is needed for the base frame and table floor, this will allow service connection back to treatment machine base and floor trench.

14.88 A lifting beam will be located over the centre of the treatment machine. Services must not cross under the beam.

14.89 Supports are required for heavy ceiling-mounted equipment such as the frames of data monitors.

14.90 Rigid support is needed for wall-mounted alignment lasers.

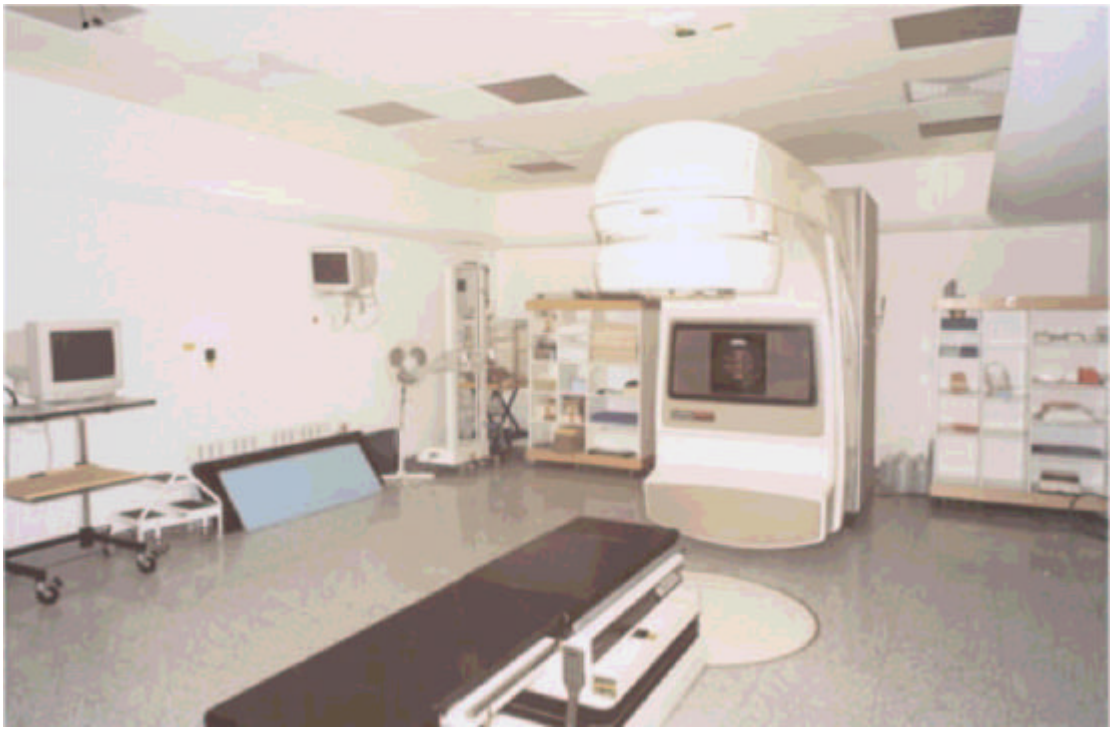
14.91 Consultation with the local radiation protection advisor (RPA) at all stages is essential.

Storage

14.92 The range of medical equipment, immobilisation devices applicators, etc., used on a regular basis in these rooms can result in a very untidy situation arising with even the most diligent staff. The consequent environment encountered by patients can prove alarming and not conducive to reducing fear and stress. Bespoke designed storage facilities, repeated in similar treatment facilities or technically matched treatment machines, will allow staff to move between these areas and work more efficiently as they will be more familiar with the arrangement from room to room.

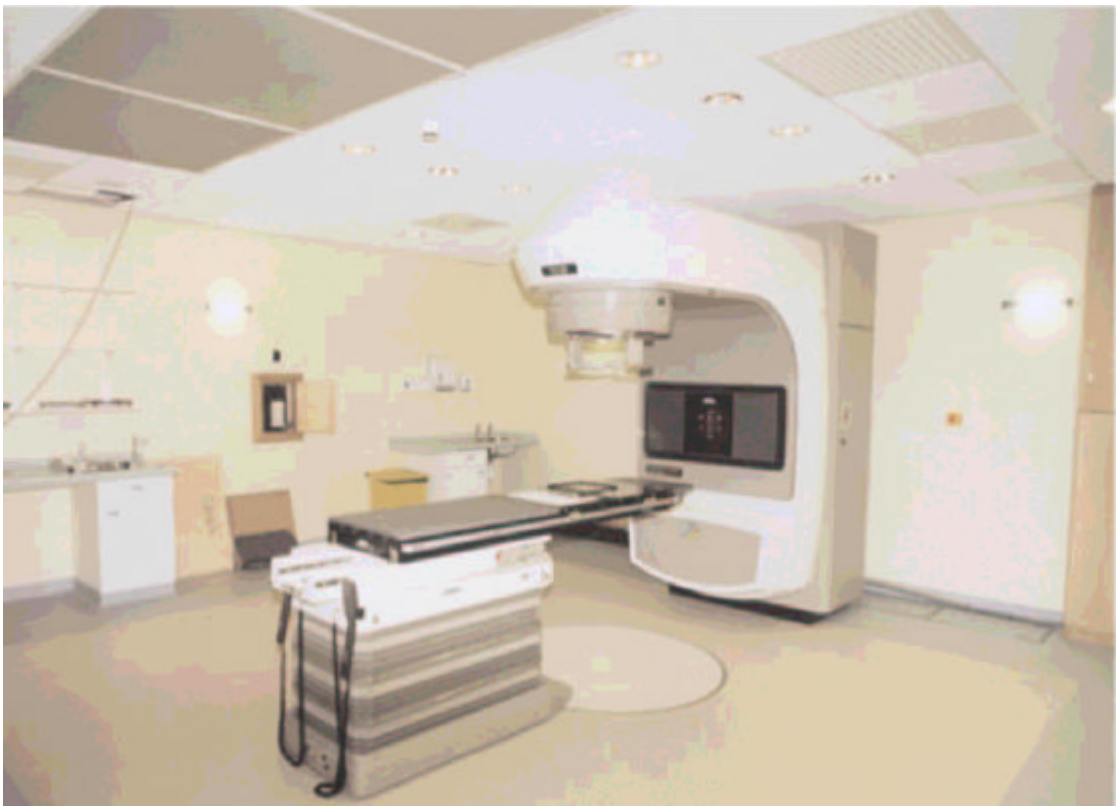
14.93 Shelving and cupboards must be adequate for all storage requirements and designed individually for each department. It is essential to liaise with users and machine specialists.

14.94 Specialised storage is needed for immobilisation devices; special lead blocks if no MLC; vacubags and body casts, etc. It should be noted that future stereotatic techniques will require a greater use of vacubags. The resulting storage requirements will grow accordingly, probably demanding separate storage and logistics arrangements.

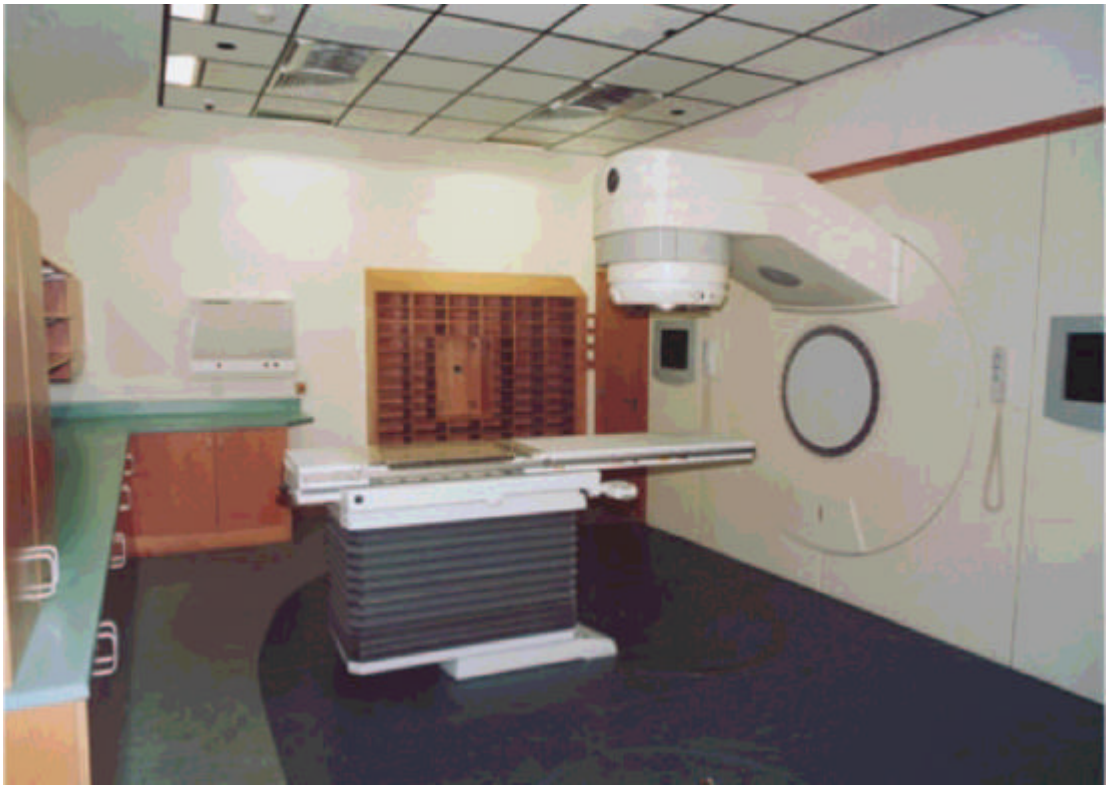


Linear accelerator treatment room showing treatment gantry with enclosed machine cabinet

Control area for recently constructed linear accelerator treatment rooms



Linear accelerator treatment room with example of linac employing an independent machine gantry



Linear accelerator treatment room where linac fascia panel is used to create a machine room

14.95 It is essential that accessory equipment e.g. breast boards, etc. should have dedicated storage, either in cupboards, on shelves or hanging.

14.96 Where necessary adequate storage must be provided for total body irradiation equipment.

Other design features

14.97 The design features which will be required will vary from project to project. The following is an indication, but is not an exhaustive list:

- drinking water;
- dispensers;
- wall-mounted dispensers for paper towels, paper cups, soap, paper sheets, etc;
- alignment lasers firmly bolted to structure, linked to laser generator using fibre-optic cable;
- last-man-out button located near entrance to maze;
- independent radiation monitor, wall-mounted;
- music for patient relaxation;
- nurse call system;

- CCTV cameras mounted at high level to monitor patient during unaccompanied periods;
- X-ray viewers, wall mounted;
- miscellaneous medical stands and trolleys.

Environmental considerations

14.98 Ventilation and the number of air changes must be adequate. In most situations air conditioning will be required complete with fail safe arrangements to prevent humidity control malfunction. Guarantees for expensive equipment may be made void if water is allowed to cause damage.

14.99 In rooms where anaesthetics are administered, there must be adequate scavenging for gas/air extraction.

14.100 Local variable temperature control is required.

14.101 It is essential to be able to dim the lighting for setting up the patient. A spotlight is required at the foot of the bed.

14.102 Music facility for the patient's own tapes/CDs, etc., should be considered.

14.103 CCTVs are required, the number is optional, depending on department practice. CCTV must have pan and zoom facility and secrecy switches. It should not be interlocked to the entry system to the maze because there are occasions when it is necessary to see what is happening in the room between times.

14.104 X-ray viewing boxes are optional, depending on department practice.

14.105 Two-way intercom to control area/room – optional.

Finishes and artwork

14.106 Murals and paintings on walls, ceilings with decorative or entertaining features, etc., are all considered to be of value in occupying the patient's mind and offering some measure of distraction.

14.107 The artwork and forms of patient distraction should be considered at an early point in the design process to allow adequate and timely consultation with the user to allow debate on the suitability of the proposals.

14.108 As there are MRSA cross-infection issues, the use of carpet is not considered appropriate. Linacs usually require anti-static finishes and have a critical level tolerance around the area of the patient bed.

Linear accelerator control areas

Note: The notes on the control areas, treatment preparation area and check-room need to be read in conjunction with this section.

14.109 The processes carried out in each area will be dependent on local work practices but space will be needed for the activity to be performed in either one of the areas.

14.110 The number of computers, keyboards, workstations, etc., will be dependent on local practice.

14.111 Early consultation is recommended to establish the full complement of equipment to be accommodated in the control area and its position relative to the maze entrance and patient areas to achieve efficiency of patient observation; ease of staff movement; data protection. When planning it should be remembered that as well as the operational staff there will often be other members of staff present who are undergoing training.

14.112 Control areas must afford space for the movement of all staff and easy access to the treatment room maze. Consideration must be given to the ability of the staff to see patients approaching the maze entrance, whilst shielding from view the monitors displaying patient information. It is essential for blind entrances to have a gate and CCTV monitoring the entrance to the maze.

14.113 The minimum depth of worktops must be 1000mm to accommodate large computer monitors. A minimum of 9 metres length will be required for each linear accelerator. There must be sufficient space between the control desk and the wall to allow radiographers to move behind each other.

14.114 Worktop height will need to be determined locally but must address health and safety issues, such as VDU use. Keyboards may be on the worktop, on pull-out shelves underneath, or a combination of the two.

14.115 Consideration must be given to issues of ventilation, dust protection, noise, heat and cabling.

14.116 The requirement for X-ray viewing boxes will be determined locally.

14.117 Daylight in the control area is highly desirable but monitors must not be subject to glare from direct sunlight.

14.118 There will be a need for a large number of sockets and computer network points in the control areas. Trunking systems that offer flexibility and change may be considered appropriate.

14.119 Easy access to a direct connection between the control area and the treatment room for QA monitoring cables is required. This penetration of the shielding wall must be aligned so that the radiation shielding is not compromised. Pre-planned underfloor ducts may be useful where distance is critical.

14.120 Consultation with the radiation protection advisor (RPA) at all stages is essential.

High-energy treatment room

14.121 To the patient, the appearance of a high-energy treatment room will be similar to that of a low/medium energy treatment room. The maze will probably be longer and the linear accelerator bigger and some differences will occur with other equipment. Apart from this little else will change visually.

Artwork

14.122 The comments made previously about the need to enhance the environment apply with equal measure in this treatment room. However, certain types of paint media are affected by the high-energy radiation beams. Care must therefore be taken when positioning artwork to avoid sites within the primary beam zone. Advice should be obtained from the radiation protection advisor (RPA) about the likely effect on any artwork proposed for use within high-energy installations

Construction issues

14.123 Despite similarities with low medium energy treatment rooms, differences will be apparent when the construction of the structural enclosure is examined. These will arise from the need to protect against increased levels of radiation energy. The concrete shielding enclosure, including the primary beam collar, will be thicker. The geometry of the shielding will be different, altering the shape of the room as well as the length and layout of the maze.

14.124 When the treatment prescribed requires these machines to be operated at high energies, a further hazard is produced in the form of free neutrons. Neutrons behave in a different way to radiation beams; as a result other measures are added to deal with the hazard that they present.

14.125 A full-height vertical recess is formed in the structural wall of the maze in the vicinity of the treatment area. The geometry of the slot or trap, as it is referred to, and the proprietary wax-like material placed in it, help to attenuate the energy of neutrons entering the maze. This wax is supported in place by a framework of hardwood studs held together with brass screws. Further attenuation takes place by positioning similar material above the suspended ceiling over the linear accelerator as well as using boron coated paper to line the walls and ceiling of the maze. For a fuller description of the protection requirements refer to the section on environmental considerations in this document.

Pre-treatment interview room (radiotherapy)

14.126 The ideal is to have one pre-treatment interview room per treatment room but this will depend on space and local practice. Room specification is similar to any other interview room. The pre-treatment interview room should be near to the

entrance/exit of treatment rooms; a minimum of one per two linear accelerators or simulators is required.

Information area and library

14.127 The information area and library will be sited locally within the radiotherapy department in close proximity to the treatment areas.

14.128 Natural light is preferable. Facility for the display of leaflets and support group booklets is required, that is, a small library with information readily available for radiographers to give to patients. Appropriate seating which is comfortable with a mixture of chair heights. Other requirements include: tables; IT points for Internet access, etc; lockable cupboards; telephone; TV/video facilities; facilities for making beverages.

Superficial and orthovoltage treatment

Treatment room

14.129 The treatment room must be of sufficient size that all areas of the body can be treated with the patients lying/sitting in a stable position.

14.130 Typically the room will need to contain: specialist shelving to house the beam defining applicators, in the case of orthovoltage these could be heavy and need to be stored at a height to meet the requirements of current health and safety legislation; a shielded window or CCTV to view the patient during the treatment exposure; a treatment couch; a bed with movements similar to a dentist chair is recommended; washhand basin; sink; lockable drugs cupboard; spotlight; interlocked door between treatment and control room.

14.131 Interior design and the provision of piped music should be considered to improve the atmosphere for the patient.

14.132 The floor must be washable.

Control area

14.133 The control area should be adjacent to the door of the treatment room. There should be sufficient workspace to contain all the equipment associated with the machine. There should be data points to support any networking requirements. There should be sufficient sockets and telephone points to meet local need.

14.134 In some cases, particularly where a high workload is undertaken, a dedicated clinic room adjacent to the treatment room may be an advantage.

14.135 Sufficient space is needed to accommodate staff being trained as well as those providing treatment.

Generator room

14.136 Provision for a sound-proofed area or room for the treatment machine generator is recommended.

Pre-treatment area

14.137 This should take the form of a completely integrated suite, encompassing interview rooms, simulators, mould room, treatment planning, dedicated CT or equivalent. Darkroom and film storage will depend on local practice.

Simulator room

14.138 The simulator room must be large enough to accommodate full rotation of the couch without collision hazards.

14.139 The orientation of the simulator, diagonal or straight, within the room will depend on space and local decision, but easy access to the couch by stretchers, beds and wheelchairs is required.

14.140 If the simulator and couch are not offset for viewing the patient, consider windows being offset to give the best possible view of the patient during simulation procedures as well as the equipment as it moves by remote control.

14.141 CT attachment is essential, particularly where access to diagnostic scanners for treatment planning is minimal.

Control area

14.142 This is usually a very busy area with radiographers, planning staff, doctors, students, etc., all needing access from time to time during the simulation procedures. The control area therefore needs to be appropriate for the working practices of the department.

14.143 Ideally there should be a separate room adjacent to the control area where conferences between different staff groups can be carried out pertaining to the patient/s of the day. Teleconferencing facilities may be helpful in the future for split-site cancer care centres. If lack of space precludes a separate discussion room, the control area should be large and remote enough for patients not to hear inappropriate conversation. If no doors separate the simulator room from the control room, a separate area needs to be allocated for general discussions.

14.144 Viewing boxes will be required even if department is digital, they will be used for films from external sources.

14.145 Other requirements include a workbench with network points, depending on equipment purchased, for doing calculations, etc., cupboards/drawers for storage (medical notes, treatment sheets, etc.), spotlight, telephone, lockable drug cupboard, shelving; general cupboards and workbench, sink, mirror, drinking water, etc.

14.146 A simulator ante-room for preparation of patients requiring barium, catheterisation, etc, is required.

14.147 Changing cubicles – see paragraph 14.72.

Treatment planning

14.148 A minimum of one workstation per two linear accelerators is needed to cope with increasingly complex techniques. This will depend on local practice and on treatment planning systems used; some systems are slow even for production of breast plans. It will also depend on the use of conformal treatment planning.

14.149 There should also be a special workstation for brachytherapy and stereotactic work because of the time taken to plan.

14.150 Planning systems are required to 'network' with different elements when planning treatments. These elements will not necessarily be within the cancer care centre or even on the same site. They include simulator, CT, MRI, these are essential, as well as links to linear accelerator and patient information systems.

14.151 Modem links are required to the supplier of the treatment planning system for 'remote diagnostics testing' as part of service agreements.

14.152 Radiotherapy target definition and associated image process and display suites are required.

14.153 Accommodation for paper and/or computer based record keeping and treatment management is required.

14.154 Film processing and laser imager rooms are required.

Mould rooms and patient immobilisation facilities

14.155 During the delivery of the treatment, it will frequently be necessary to immobilise the patient to ensure the safe, accurate delivery of the radiotherapy treatment. To achieve this, a mask is made from thin plastic sheet, individually produced to match the patient's features, so that it can be fitted on to the patient and secured to the treatment couch, thus restricting movement during treatment.

14.156 To align the part of the body to receive radiation treatment, it may often be necessary to prop or support a particular part or limb of the body. This is achieved with air-filled sacks or foam blocks that may be readily available as standard items or may have to be specially produced to accommodate a particular situation. These items are custom-made in the mould room suite.

Patient fitting room

14.157 This is the room in which the patients will be fitted with immobilising shells or supporting devices. The process may be lengthy and unpleasant, and may involve the taking of impressions using plaster of Paris. To ease the process for

the patient, the room should offer a light, airy environment and be as comfortable as possible.

14.158 The technicians will need to view imaging data and carry out clerical work and reporting. A workstation should be provided with a computer network point, sockets, telephone, filing cabinet, etc.

14.159 The patient will usually need to remove clothing, therefore changing facilities with a curtained area will be needed.

14.160 The dignity of the patient should be considered when locating the couch in relation to doors.

14.161 Ceilings may be designed with some point of interest to relieve patients' boredom.

14.162 Background music with facilities for patient choice may be considered.

14.163 A shower and changing area with mirror, shelf, seat, , curtain or door and coat hooks will be required.

14.164 Seating should be provided for relatives or carers accompanying patients. Mobiles, stencils, toys, etc., for children are useful for relieving boredom.

14.165 Wheelchair/bed access is essential.

14.166 Locally adjustable heating and ventilation to give patient and staff relief from local heat gain and smells is essential.

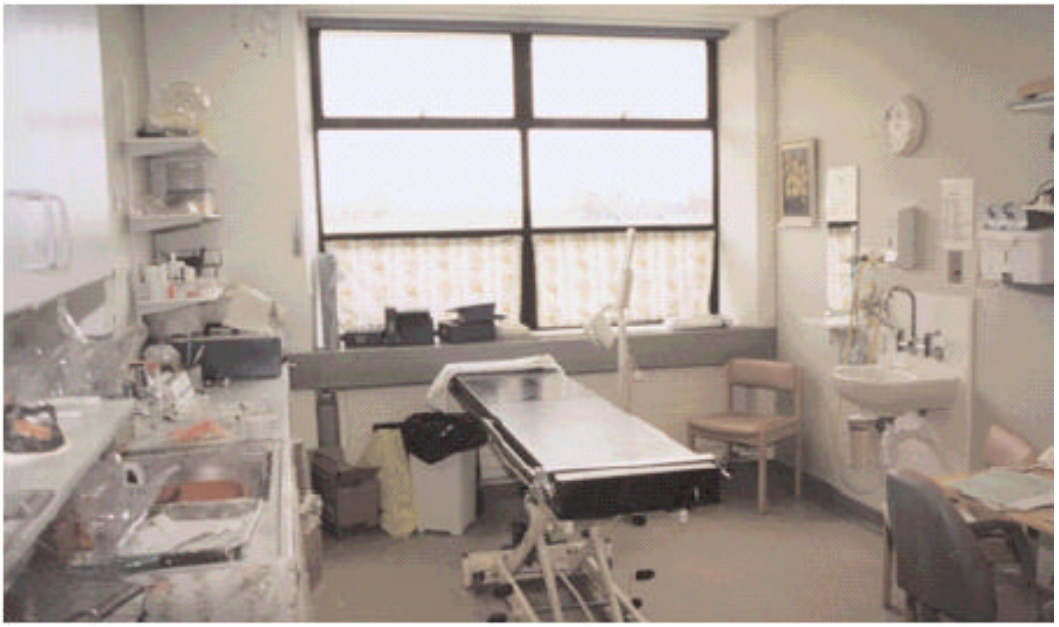
14.167 The floor covering should be linoleum or vinyl with coved skirting for ease of cleaning.

14.168 The plaster trap sink will require a tiled or other form of splash-back. The trap must be easily accessible as it requires regular, and easy, cleaning.

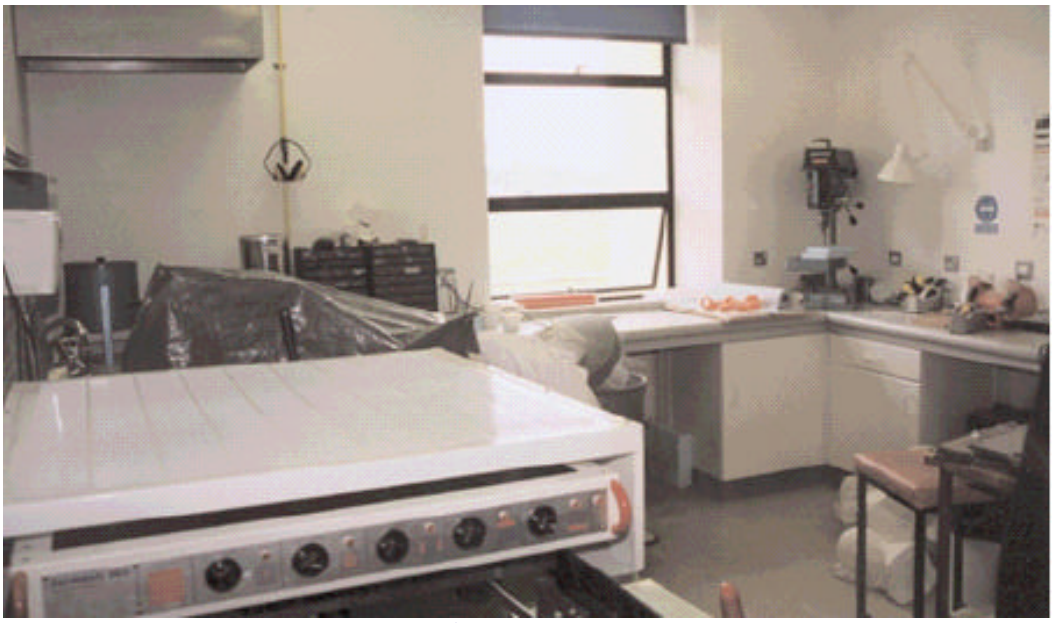
14.169 A hot water bath will be required if using thermoplastics for immobilisation.

14.170 Alignment lasers and variable height treatment to mimic the treatment area are needed.

14.171 A height-adjustable couch will be required.



Mould room workshop showing typical patient preparation area.



Mould room workshop showing profile machine, low temperature alloy smelting area with extract hood.

14.172 A dentist chair, relocatable frames, etc., will be required for departments intending to use stereotactic techniques instead of shells.

Machine room and workshop

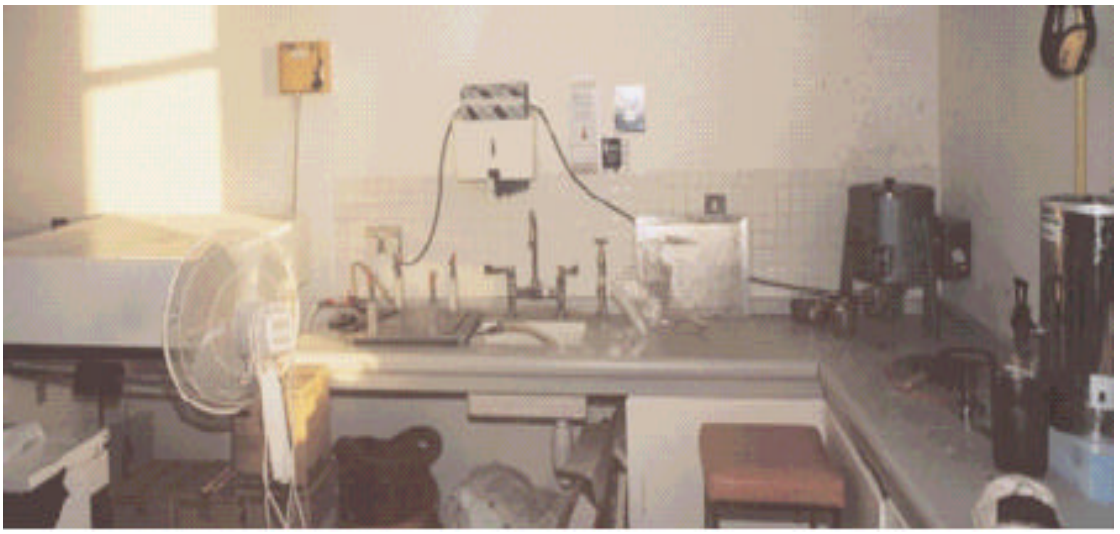
14.173 The immobilising shells and supporting devices are fabricated here. The processes include:

- vacuum forming techniques;
- injection moulding;
- cold setting resin formulations;
- epoxy/polyester techniques.

These processes are essentially light engineering in character. Workshop conditions are required with appropriate floor and wall surfaces. A good general level of lighting is needed with task lighting at workstations.

14.174 Ideally the machine room should be separate from the workshop assembly area, as assembly and adjustment require concentration and cleaner conditions.

14.175 Good ventilation is essential and cooling will have to be considered due to equipment heat output. Local extraction will be required over processes generating dust and fumes. Consideration needs to be given to the provision of three-phase electrical supply and a floor drain. Equipment will depend on project requirements but is likely to include: LMP cutter/compensator maker and melting pot in laminar flow cupboard or equivalent; vacuum forming machine with compressor; contouring device, this will depend on local practice; electric furnace; electric oven; saws; bandsaw; bench drill; bench grinder; bench sander and polisher; hot wire cutter; wax bath; various hand-held tools and workbench, this could be mobile, on a trolley; bunsen burner; work benches; storage cupboards; compressed air outlet; wall-mounted viewing boxes; telephone and network point to planning and HIS; plaster trap sink.



Mould room workshop area

14.176 Staff should be able to leave the machine room and workshop without having to pass through the patient fitting room.

Storage

14.177 Adequate and appropriate storage is essential in all areas of this key supporting facility. The activities carried out are diverse in nature, requiring access to a wide range of materials and tools including plaster models, bandages, Uvex sheets, etc., size will depend on local activity and practice. To carry out this work effectively, work areas and conditions generally need to be well organised.

Stereotactic radiotherapy facilities

14.178 The design of the treatment couch is such that it will accept interchangeable body shells, uniquely moulded to fit each patient's body shape. The body shell will need to be kept for as long as the patient is receiving treatment and may, during this period, need replacing to allow for changes in the patient's body.

14.179 This technique will generate a considerable demand for storage of body shells. They will also require labelling and cataloguing. Early consultation with the project team will be essential to assess the extent of storage if stereotactic radiotherapy is proposed.

Paediatric facilities

Procedures room

14.180 A procedures room used to carry out minor treatments and procedures such as dressing changes will be necessary close to bedroom accommodation. Ideally there should be two procedure rooms for every 15 beds and they should be located away from the bedroom areas so that those remaining in their rooms are not disturbed by noise from the procedure room. The rooms should take the form of a treatment room as described in NHS Estates guidance HBN 23 'Hospital accommodation for children and young people', may be used with general caution by NHSScotland.

Recovery area

14.181 This provides for the recovery of the patient after a procedure often involving anaesthesia. The recovery can be supervised without preventing the use of the procedures room for further patients. As this area may have high voltage electrical equipment, water and other fluid services should be avoided above this room.

Offices

14.182 Outreach nurses play an important role. Many patients will spend time at home between periods in hospital and the outreach nurse will give support during this period. Close liaison between the staff involved with a patient in hospital and the development of a relationship with the patient in hospital is very important. The

office accommodation should be integrated with, or be as close as possible to, the children's accommodation.

14.183 Offices for social workers will be required. There will be a greater number of social workers and other supporting staff associated with a children's cancer facility than other childrens' illness or other departments of a hospital, as a result of the traumatic effect that this illness can have, not only on the patient but their whole family.

Other accommodation

14.184 Other accommodation is required as follows:

- play therapy room;
- school room;
- rehabilitation room;
- office for anaesthetist;
- single bedrooms with parent accommodation;
- single bedrooms for barrier nursing with air-conditioning or special ventilation arrangements;
- iodine treatment room, en-suite, with radiation barrier, to allow visitors into room;
- brachytherapy room;
- recreation room with access restricted to 'young people' only;
- parent accommodation suite for longer stay, separate but nearby;
- interview rooms/multi-disciplinary rooms/seminar staff training rooms.

Clinical support spaces

Medical physics and bioengineering accommodation

14.185 The medical physics department will serve the needs of many departments in the hospital. However, certain facilities within medical physics are essential to the routine operation of cancer care facilities.

Mechanical workshop

14.186 In PFI schemes it is common for the responsibility for maintaining linear accelerators and other equipment to be transferred to a third party, usually the equipment manufacturer or its agent. However, workshops will be needed where equipment maintenance remains largely in-house or where prototyping work or bespoke engineering devices are required in support of research purposes.

14.187 The workshop character is generally one of a well-equipped engineering workshop with a selection of lathes, drills, grinders, saws, etc. A three-phase electrical supply will almost certainly be required in this room.

14.188 The construction and layout of equipment must meet the requirements of current health and safety regulations. Storage will be needed for tools. Facilities for lifting heavy objects will be required eg overhead rail and hoist.

14.189 Robust wall finishes and slip and oil resistant flooring will be essential. Good natural and artificial lighting is essential. Solar control and mechanical ventilation will be needed. Air extract systems will be required to remove fumes caused by welding, etc.

14.190 Storage of a full range of materials should be located conveniently for retrieval and use. Access for deliveries by lorry to the store should be considered. Working facilities for equipment should be provided. As fluids are sometimes stored here, a floor gulley may be required in order to help with the cleaning up of any spills. Contamination from the liquids concerned may need special arrangements in the drainage design, appropriate consultation should be undertaken with the RPA and local authority.

Electronics workshop and development facilities

14.191 An electronics workshop will be needed so that the task of maintaining the integrity and safety of the wide array of electronic equipment that will be found in a radiotherapy facility can be performed.

14.192 The standard of work carried out is demanding, requiring considerable expertise therefore the conditions for performing this work are important. A clean, dust-free environment is important, as is good quality general lighting with task lighting at the workbench positions. Natural lighting and ventilation is required but solar control and mechanical ventilation may be needed to maintain suitable temperatures for working.

14.193 Other requirements include: generous benching with cupboards and drawer under; bench-mounted trunking to allow power outlets as required; space to perform record keeping and logs; shelving for manuals; bookcases; and a computer workstation. Anti-static arrangements will need to be made.

Quality assurance and dosimetric laboratory

14.194 Quality control and calibration of machinery is an essential and regularly performed task. Much of the work will be performed on machines and equipment located in their respective room or area which will, more often than not, be located some way from the medical physics department. For this reason it is seen as important to provide a suitable room, near to the cancer care facility to act as a local base for this function to be carried out.

14.195 Considerations for inclusion within this area include: secure room; storage of manuals and records; storage of measuring equipment; worktop for bench-

mounted equipment including bunsen burner; worktop for routine tasks; computer workstation; telephone.

Secure room

14.196 Functions and requirements include storage of manuals and records; storage of measuring equipment; worktop for bench-mounted equipment including bunsen burner; worktop for routine tasks; computer workstation; telephone.

Sealed source store brachytherapy

14.197 The function of this room is to provide a suitable environment for the receipt, storage and handling of solid or sealed radioactive materials which are used to administer radiation treatment by either local application or interstitial insertion.

14.198 The design must comply with the Code of Practice for Ionising Radiation.

14.199 An area will be needed for recording radioactive materials in stock and in transient use. Storage will be required for shielded containers used for transporting radioactive materials and for applicators and accessories in regular use.

14.200 A shielded workbench, normally constructed using lead, is required to allow staff to handle and prepare radioactive sources for clinical use. Due to the weight of lead shielding needed, localised floor loading will be abnormal and will need to be taken into account, either by design of the structure or siting.

Medical physics support accommodation

14.201 A number of offices are needed, these will vary depending on the project size:

- senior physicist's offices;
- secretaries' offices;
- physicists' offices;
- laboratory/physicists' offices.

Record keeping facilities

14.202 Cancer registration, ie the careful keeping of records of treatments and outcomes is essential to the successful development of cancer care. The dissemination of information to the cancer registries allows comprehensive data to be compiled allowing trends related to epidemiology of the disease, treatment and survival rates to be carried out. Office facilities will be necessary, as will storage for paper records being processed.

Phlebotomy – venepuncture rooms

14.203 Facilities will be required for taking and testing blood specimens.

14.204 A venepuncture room may need to accommodate more than one patient at the same time. In order to preserve patient privacy and dignity in such cases the venepuncture room should include individual cubicles.

14.205 Each venepuncture area will require a venepuncture chair, storage facilities for a working stock of sterile and other supplies, and clinical hand wash facilities. Normally, only the phlebotomist will attend the patient.

Bereavement facilities

14.206 Refer to NHSScotland guidance Scottish Health Planning Note 20 'Facilities for mortuaries and post-mortem room services'. It will be necessary to provide facilities where relatives and those close to someone deceased can come and spend some time with the body.

14.207 The aim of the interior designer should be to create a serene and reassuring surroundings using colour, texture, lighting and environmental control to best effect.

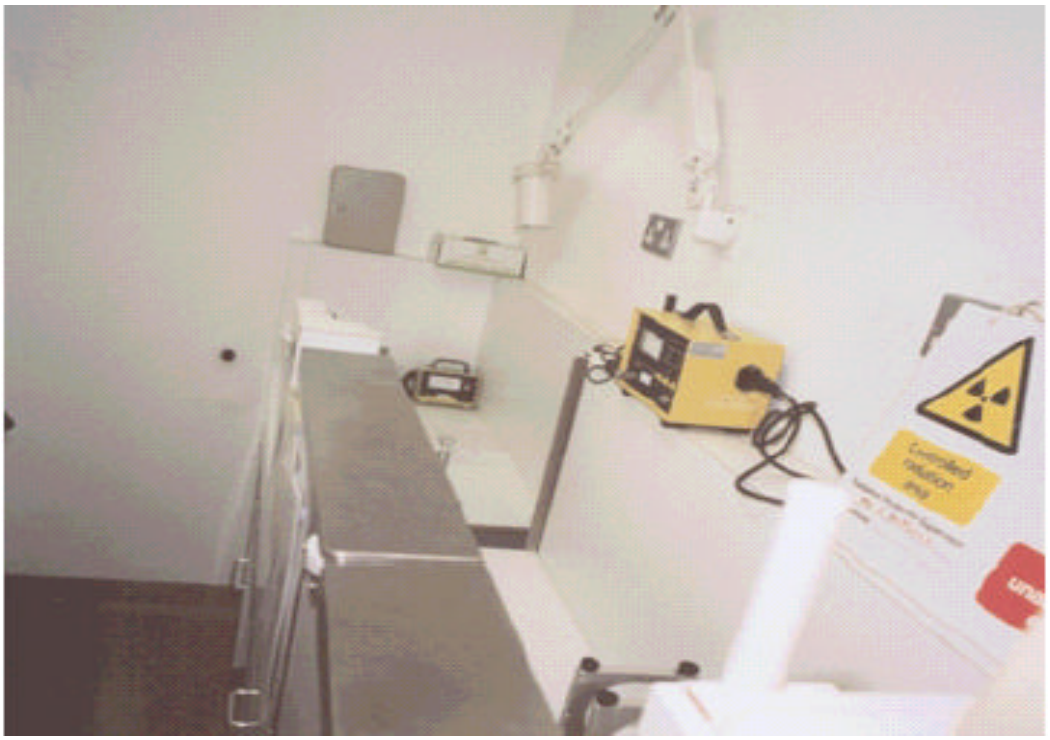
14.208 It is important to remember that the area should be able to accommodate those religions and cultures that are likely to use the facilities.

Mortuary accommodation

14.209 Refer to NHSScotland guidance Scottish Health Planning Note 20 'Facilities for mortuaries and post-mortem room services'.

Contaminated articles store

14.210 Articles, materials or equipment that are contaminated with radiation will need to be stored in a safe place until the radiation has fallen to a safe level. This is commonly dealt with by collecting the articles in a shielded container and taking them to the contaminated articles store for storage until safe. The contaminated store is described elsewhere in this document.



Sealed source store showing shielded workstation

Microbiological safety cabinet used in radio -pharmacy preparation area

Patient support spaces

Complementary medicine facilities

14.211 Complementary therapy requires a relatively relaxed environment of a domestic character, with use of diffused low light levels, although the ability to increase the light level during therapies may be necessary on occasion.

14.212 A relatively small room is preferred and this should be capable of comfortably accommodating the patient and up to two professionals, together with possible attendance by a relative or friend.

14.213 The patient will ordinarily be supported using a clinical couch with a low permeability soft finish capable of easy cleaning, particularly in respect of oily substances. The couch must feature a tilting or backrest facility which may be used to ease access to the patient's back during aromatherapy. While in reflexology, the patient would normally be in the supine position.

14.214 It is important that the sound levels in the room, especially arising from extraneous sources, should be well controlled. Accordingly, consideration should be given to the use of sound insulating materials in walls, doors, etc. It may also be important to locate the room in a part of the building where the other surrounding activities are themselves quiet and where the traffic of persons is light. The floors should be finished in readily cleaned materials such as welded vinyl or linoleum, though rugs may be utilised in order to soften the appearance and give a more domestic quality. Walls require non-glossy finishes in colours chosen to generate a relatively subdued and relaxed character.

14.215 For aromatherapy it may be necessary to change from one oil to another with widely differing aromatic qualities. Accordingly, there is a need to remove the scent of the preceding treatment. In light of this, some degree of mechanical ventilation to the room allowing for occasional rapid air changes, at least 20–30 air changes per hour will be needed. This need not imply a fully integrated mechanical system where this is not generally provided within the remainder of the building.

Reasonable standards of temperature control are required in order to promote effective use of the aromatherapy and reflexology technique.

14.216 The use of potted plants as a feature within these rooms is common. Use carefully designed wall-wash lighting or uplighters. Similarly, waiting rooms that are partly or wholly devoted to serving suites used for alternative therapy should be relatively relaxed and subdued with soft furnishings and plants. In some applications, devices to generate pleasant aromas within waiting areas have been used successfully.

Support group rooms

14.217 See also NHS Estates guidance Health Building Note 36 'Local healthcare facilities', Vol.1, 4.91, which may be used with general caution by NHSScotland.

14.218 As part of the patient support movement that underpins both therapeutic and palliative treatment of cancer, patient collaborative or support groups play an invaluable part in improving the quality of life for patients and their carers.

14.219 Cancer care centres should include a multi-purpose room that will accommodate between 10 and 15 people. This may be sufficient to meet the needs of cancer patients as well other patients. Local needs and resources should be reviewed.

14.220 Consideration should also be given to the provision of the following:

- patient information facilities;
- telemedical facilities.

Psychological and psychiatric accommodation

14.221 Accommodation will be required for patient counselling or used for giving psychiatric help. Small rooms, capable of accommodating up to four people in an informal setting are required for this purpose.

Patient retreat facilities

14.222 It is considered to be very important that patients can retire at times to an area that is dedicated to their use and free from all clinical staff. The nature and position will vary but should be informal in nature. The area or room should allow individuals or small groups to use the facility.

General design considerations

Internal routes of access and departure

14.223 Patient and staff flow patterns normally used for day-to-day use will have been established. These will involve the use of identified entrances and exits from the building. However, advice has been received from numerous sources, not least a report for NHS Estates by Cancerlink, highlighting the need for a discrete exit from the building for those who have just received bad news. The support for this facility makes an overwhelming case for inclusion in any new facility. It should also be considered as an improvement to any existing building where appropriate.

Building access considerations

14.224 Access to the building and its facilities for both patients and staff is a fundamental consideration. Guidance dealing with basic design considerations and building management to ensure the continuance of access and means of escape is available in existing publications and regulations. These cover access from the perimeter of the site, approaches to the building and use within the building. References include:

- NHS Estates guidance Health Building Note/Scottish Hospital Planning Note 40 'Common activity spaces';
- The Scottish Building Regulations;
- NHSScotland guidance Scottish Hospital Planning Note 45 'External works for health buildings'.

Equipment access

14.225 Equipment access to treatment rooms will require very careful consideration, both for initial delivery and future replacements. Some equipment may be able to be delivered through the maze but some larger or heavier equipment may require special consideration. Where equipment is delivered early, and further building work is required to complete the closure, the question of protection and responsibility of the valuable equipment are important contract issues.

Waste disposal

14.226 The workshop will generate waste which is normally disposed of in waste skips. The location of the skip should be considered. Imaging machine waste disposal is best outwith the building, and relies on gravity feed to containers which require special disposal. This may involve external pits due to the normal requirement for Linac Rooms on ground floor, as well as vehicular access to the pits.

The Disability Discrimination Act (DDA)

14.227 DDA 1995 introduces new laws and measures aimed at ending the discrimination that many disabled people face. Over time, the act gives disabled people new rights and places new duties on, among others, employers and service providers. References include:

- Scottish Health Facilties Note 14 'Disability access';
- Access Audit Checklist: 'Access for disabled people in healthcare premises';
- Good Practice Guide: 'Equality for disabled people in the NHS in Scotland', issued by SEHD.

It is recommended that readers consult bodies such as:

- local disabled user group organisations;
- the Centre for Accessible Environments.

Access audits should be carried out at design and completion stages as the DDA will be fully implemented from October 2004.

Special facilities for individual or small group catering

14.228 Patients suffering from disease or from the effects of their treatment often do not wish to eat at prescribed times. They may have very specific dietary requirements or other difficulties with eating that require special measures. For these reasons, consideration should be given to providing catering facilities for in-patient accommodation that will meet these special situations. This may not easily fit in with current local arrangements.

14.229 In some cases, where particular difficulties are experienced when eating, staff advice and patient practice may be needed. This should take place in a room away from the main accommodation areas where patient dignity can be maintained.

Special construction features

14.230 Special care is required when constructing the treatment room's primary shielding, particularly where joints are required. Day joints in concrete structures require special consideration to avoid radiation paths through them.

15. Radiation protection in cancer services

Use of radiation in cancer services

15.1 Radiation that may be detrimental to a whole healthy living organism can conversely be helpful where the damaging effects of the ionising radiation are concentrated on a tumour or other form of cancer. It is this basic phenomenon which is responsible for the treatment uses of radiations in cancer care services. There are also a range of diagnostic uses where the aim is essentially to minimise the amounts or dose of radiation involved, while maximising the information yield from the test concerned.

15.2 When planning and designing for radiation uses in cancer care services, early consultation with the local radiation protection advisor (RPA), ordinarily employed by or contracted to a Trust, is advised and may be required by statute. Each existing centre, department, etc., will also have appointed a Radiation Protection Supervisor (RPS) who is necessarily a member of staff. This RPS will be a good source of information on local practices and safety rules.

15.3 Therapeutic uses of ionising radiation in cancer care services divide into two categories, previously described in detail. These are:

- teletherapy, in which X-ray or gamma beams are generated by a machine and used to treat a tumour with the X-ray source being outside the patient's body;
- brachytherapy and unsealed source treatments. These are basically the same except that they will use chemical or nuclear sources of radiation and these will be within the patient's body, either as a solid material, for brachytherapy, or as a solution in unsealed source treatments. Unsealed source therapies would include treatment for thyroid cancer using radioactive Iodine 131.

Containment of radioactive materials and prevention of contamination

15.4 The use of radiations of nuclear origin as unsealed radioactive sources, essentially liquid solutions, has been mentioned above and is dealt with in detail elsewhere in this document. As these radioactive materials are liquid solutions, there is clearly a possibility that they will escape from the containers or containment within which it is intended that they will remain. This is particularly true when the radioactive material is given to the patient as a drink or introduced into the body by an intravenous injection. In the former instance, the radioactive solution itself may be subject to leakage from its container or to accidental spillage. In the second instance, the patient's urine, sweat and other

body fluids may become radioactive due to the presence of the radioactive material in solution.

15.5 Coming into contact with these unconstrained radioactive solutions is known as radioactive contamination. Simply, the contaminated surface or person has the liquid radioactive solution present and this in turn may give rise to the possibility of ingestion. Clearly, as in these circumstances, there is no separation between the radioactive source and the person concerned, so the probability that high radiation doses will be delivered may be expected to be increased.

15.6 Much design work in regard of the facilities within which these unsealed sources are used is aimed at minimising the risk of radioactive contamination and being able to deal with it quickly and easily should it occur. This implies the use of impermeable and easily cleaned smooth surfaces and careful attention to jointing. Sinks will be such as to resist permanent contamination, particularly if used for waste disposal. Washhand basins are an essential provision and these shall be of ceramic construction with foot or elbow operated taps.

Internal view of linear accelerator bunker under construction using blocks of alternative shielding materials. Joints are formed using specialised proprietary mortar. Shows services entering from maze corridor and steel joists supporting roof structure.

Constraint of radiation dose and the use of shielding

15.7 The reasoning behind the need to restrict or minimise radiation dose has been established. There are three essential mechanisms by which dose can be reduced. These are:

- minimising the time or period of exposure to the radiation;
- maximising the distance between the radioactive source and any persons who may be present;
- the introduction of a barrier or shield between the source of radiation and the people to be protected.

15.8 The amount of shielding that will need to be used in any given circumstance depends essentially on the quantity of radiation being produced; the distance from the point of production to the area needing to be protected; and thirdly, the type of radiation involved. It will be readily appreciated, therefore, that shielding types and magnitudes vary markedly. Detailed accounts are given at appropriate points within this document but the following summarises the common shielding strategies:

- teletherapy involving the treatment of patients with X-ray beams derived from linear accelerators or gamma ray beams from Cobalt 60 machines. Here, the effectiveness of the shield is controlled in part by the sheer mass of material present. This being the case, the use of dense materials, most commonly concrete and steel, is favoured. The masses involved will be such as to have major design and structural implications for the building used. In very recent times, alternative materials such as 'Ledite' have become available and these will in some instances offer special advantages in terms of reducing the volume or space occupied by the shield. To some degree the effectiveness of all shields is influenced by their shape and geometry but in the case of linear accelerator bunkers and their shielding walls, this is particularly important;
- neutron protection. This is an exception to the high energy radiation beam shielding methodologies briefly mentioned above. Neutrons are only produced by a very small minority of linear accelerators, specifically those operating at above 8.5MV, with the problem or challenge being especially notable above 12MV. The neutrons penetrate heavy and dense materials relatively easily, unlike X-rays or gamma rays, but are stopped by hydrogenous materials which are very light and preferably should be Boron-loaded hydrogenous materials. Accordingly for the special high energy linear accelerators where neutrons are produced as an unwanted by-product, the use of very low density shielding materials in addition to the concrete and steel will be necessary. The design of these neutron shields is a highly specialised process requiring detailed advice from a qualified source;
- sealed and unsealed radioactive sources. Again, the radiations produced by these sources will lead to detriment if adequate shielding of the sources is not used. However, in the majority of cases, it is more practical to surround the source with the shielding material, often lead, rather than to surround the room within which they are contained. In some instances, however, both strategies will be needed in order to meet practicalities and provide an adequate level of shielding to ensure reasonable safety;
- lower energy X-ray beam shielding. For the more modest energy teletherapy treatments, such as superficial and orthovoltage as well as all

diagnostic X-ray uses, room shielding will be more modest but nevertheless essential. Here, doors, window frames, etc., will often be shielded by modest thicknesses of lead, say, 1–3 mm. High-density building block options are also frequently employed. A relatively modest glass containing lead salts or equivalent plastic base materials can be used for windows with high standards of visibility into the area where the radiation source, normally an X-ray tube, is present.

UK Legislation

15.9 There are three major items of UK legislation that affect the design and operation of cancer care facilities with particular emphasis on some diagnostic and all radiotherapy departments. These are as follows:

- The 1999 Ionising Radiations Regulations and HSC approved Code of Practice;
- The Ionising Radiation (Medical Exposure) Regulations 2000;
- The 1993 Radioactive Substances Act.

16. Basis of environmental protection

Introduction

16.1 The potentially toxic materials used in the clinical aspects of cancer care services require careful handling and use, and particular concern surrounds disposal of these materials. Equally, cancer services buildings can be of particularly heavy construction, for example in radiotherapy departments, so the environmental impact of demolition may be significant.

Concept of radioactive discharge

16.2 In essence, just as there is background radiation so there is also background radioactive material present in the normal environment. Principally, this will consist of long-lived derivatives of natural uranium which ultimately gives rise to so called 'soil gas' or, more correctly, radon. This gas makes a marked contribution to natural irradiation of the population. Given that this is the case, it is clearly important that we restrict the degree to which we add to the level of radioactivity present in the environment. Broadly, the use of relatively short half-life radioactive materials in medicine counters this challenge effectively but some longer half-life material is also used.

16.3 Wherever reasonably practical and permitted by law, radioactive materials will be dealt with by the simple expedient of leaving them to decay until they reach an essentially safe or non-radioactive state. This will involve the construction of suitable storage facilities known as ‘decay stores’. However, for longer-lived materials, some discharge to the drainage system of the hospital, or into the air as a result of disposal by burning in approved incinerators, will be necessary. Discharge to drains or into the air may also occur routinely in the use of radioactive materials or as a result of accident.

16.4 It is important that the design of the building within which these radioactive materials are used constrains their release into the general outside environment to be at, or below, levels that have been pre-determined and agreed with the Scottish Environmental Protection Agency (SEPA). This agency has the responsibility to licence such disposals under the Radioactive Substances Act.

Minimisation of discharge and environmental impact

16.5 In principle, the discharge minimisation springs from concepts devised by the International Commission for Radiation Protection (ICRP) which states that radioactive materials should only be used where there is no viable alternative. However, where their use cannot be avoided, we are required to model and assess the levels of radioactive contamination that may be expected in the environment, particularly in respect of watercourses into which radioactive fluids

may be discharged. Dilution factors are critically important here; if a discharge can be rapidly diluted by enabling a drain to join with others of larger flow and capacity at an earlier stage, so the dilution will minimise radioactive concentrations and the hazards associated with that, though the overall discharge is unaffected. This is important to the water system engineering of many cancer care services buildings.

16.6 The administrative structure for the control of radioactive discharge and environmental protection will be common with that used for radiation protection in the great majority of healthcare institutions. Accordingly, the radiation protection advisor (RPA) will also render advice on the environmental impact and will be responsible for the generation of environmental impact models as needed.

16.7 When undertaking building design, the estimation of the environmental impact of radioactive discharges should be considered at an early stage. The presence or absence of such discharges, as well as the levels that may be expected, will be critically dependent upon the clinical tasks undertaken. In particular, nuclear medicine and the treatment of patients by the use of radioactive iodine will influence the level of discharge significantly. It is important to note that patients who have received radioiodine or other unsealed materials will discharge these in the form of body fluids, most obviously urine. For some of these treatments a great majority of the radioactive material administered will appear in urine and will accordingly be discharged over a short period of time, a few hours, into the drainage system of the hospital or other healthcare environments. This element of radioactive discharge is, in practical terms, unavoidable.

Population radiation dose and effective control

16.8 Clearly the discharge of radioactive materials from sites or institutions that make use of such contributes to population dose. However, the contribution from medical discharge is small and although this will be taken into account in modelling conducted by the radiation protection advisor (RPA), it is unlikely that this will result in constraint on medical activities on a given site. However, local limits for discharge exist and these should be carefully observed at an early stage in the planning process.

Decommissioning of facilities

16.9 Essentially, wherever radioactive materials are used, be they sealed or unsealed, the possibility of the long-term build-up of radioactive contamination may exist. However, in the modern era, the controls exerted on sealed sources should, particularly in healthcare institutions, be such as to mean that their chronic loss will not be tolerated or encountered. Accordingly, the need to examine the built environment for such sources is no longer prevalent, though incidents may occasionally occur and rooms where such sources are handled should be designed with this in mind. Specifically, it is helpful if gaps and surface discontinuity are avoided.

Single bed LDR/MDR treatment room showing window in external shielding wall. Shielding continuity is maintained by use of a free-standing concrete shielding wall enclosing a controlled area that can be landscaped for the benefit of the patient.

16.10 More commonly, unsealed radioactive sources present as liquid solutions may give rise to chronic contamination of the rooms in which they are used and most especially the drainage system from that room if discharge to drains is permitted. In this case, the RPA should be consulted and records examined to determine the nature of the radioactive materials present and, in particular, their effective half-life in that environment. If the half-life is short, it may be wise to delay dismantling the pipework, etc., for an appropriate period of time so that radioactive decay can effectively remove the hazard. Where the half-life is long or such delay cannot be accommodated, special precautions will be necessary and the pipework itself may constitute solid radioactive waste. Should this be the case, the RPA will write a decommissioning scheme of work and will also undertake to work with SEPA to ensure appropriate ultimate disposal of the materials.

16.11 In respect of the above decommissioning of unsealed radioactive source sinks, drains, etc., there is a particular need for care if chemical agents are being used to reduce the radioactive burden. In particular, care must be taken when decommissioning teams use chemicals, including bleach, since these may oxidise some radioactive materials in solution, rendering them insoluble. Such process may then result in radioactive gases being released into the immediate environment, giving rise to an increased hazard to workers. Detailed professional advice must always be obtained for each specific situation and the use of general rules is unwise.

16.12 Generating radioactive materials within the structure of machines or in the built environment that contains them is often poorly understood as a part of a decommissioning process. In the great majority of cases, the X-ray or gamma

ray beams employed by X-ray machines and linear accelerators do not generate radioactive induction in the built environment or structures around them. Accordingly, for the huge majority of such installations, there are no special decommissioning criteria and no special precautions need be taken in respect of radioactivity.

16.13 Linear accelerators operating at above 8.5MV are capable of inducing radioactive activation in their own structures, most notably the collimators or jaws as well as parts of the couch. In very unusual instances, this activation may extend to the built environment of the bunker shielding that surrounds the machine. However, good design can virtually eliminate this as a consideration while in older, poorly designed units, the extent of activation and the half-life of the radioactive materials present is such that special precautions are not likely to be needed. However, when high-energy linear accelerator bunkers are being decommissioned, a radioactivity site survey should be conducted and the RPA consulted as to whether or not special precautions are needed in the specific instance. It is unlikely that the move toward new materials such as 'Ledite' will materially affect radioactive activation, though the potential re-use of 'Ledite' is a factor.

Economic considerations

16.14 The decontamination and radiation control issues mentioned above are not likely to add severely to decommissioning costs in radiotherapy and nuclear medicine facilities. However, the business of using possibly very large amounts of shielding does have a potential impact and the problems associated with the disposal of that shielding at the end of the useful life of the facility should be considered. Bunkers should therefore be constructed to take in the future, high energy and larger machines wherever possible, to enable flexibility in future use.

16.15 Reinforced concrete structures are amenable to removal only by on-site breakage and demolition. The waste materials are then conventionally removed from site using heavy vehicles and are disposed of by landfill or, in some instances, a recycling process, which involves crushing the material. By contrast some of the new shielding materials, 'Ledite' being the best known example, are amenable to re-use and can simply be dismantled and either returned to the supplier or redeployed in new buildings. In considering the overall costs within a business plan, particularly for a radiotherapy development, an assessment of environmental protection and impact in respect of demolition or reuse of materials is a relevant consideration.

HDR control area showing the afterloading machine control and monitors.

17. Control of infection in cancer patients

Introduction

17.1 Infectious diseases and healthcare associated infection represent an increasing problem for hospitalised patients and a major cause of morbidity and mortality in patients with compromised immune systems. Readers are referred to the NHSScotland guidance Scottish Health Facilities Note 30 'Infection control in the built environment - design and planning'.

17.2 All patients, staff and visitors to healthcare institutions are subject to a measure of exposure to possible cross-infection due to the obvious concentration of disease within such buildings. There is accordingly a clear duty of care, frequently reinforced by government measures, to minimise such risk at every reasonable opportunity. Control is dependent upon the generation of suitable policies and protocols at local level, but also necessarily involves attention to detail in building design.

17.3 Readers are referred to NHSScotland guidance, Scottish Health Technical Memorandum 2040 – 'The control of legionellae in healthcare premises – a code of practice'. Further detailed advice on the prevention of infection spread through pharmaceuticals is contained within Health Building Note 29 'Accommodation for pharmaceutical services'. Much of the latter advice will apply to radiopharmaceuticals.

Vulnerability of cancer patients – general and specific

17.4 The group of patients discussed in this document may have a broad variation in immunological function and for this reason and because individual immunological functions will vary according to the stage of treatment, it is difficult to be prescriptive.

17.5 The risk of infection for cancer patients as a group has not been shown to differ substantially from others suffering acute illness. However, an exception exists for those who are immuno-compromised as part of treatment for a range of diseases, most commonly leukaemia. Such treatment may involve total body irradiation followed by a bone marrow transplant and a long period of infection-protective nursing. This is a particular consideration in paediatric services.

17.6 Cancer patients may have complications in terms of other diseases that potentially give rise to enhanced vulnerability. The skew inpatient–age distribution towards older age groups should also be noted.

Sources of risk

17.7 A number of diseases pose quantifiable levels of risk for infection in healthcare premises, particularly hospitals. Prominent among these is methicillin resistant staphylococcus aureus (MRSA) but the range of hospital-acquired infections (HAI) is wide and the prevalence amongst patients is as high as 10-12%. This can give rise to a significant additional hurdle that must be overcome in the provision of satisfactory care for cancer patients. A summary is provided in The Socioeconomic Burden of Hospital-acquired Infection, available from Public Health Laboratory Service or the Department of Health Web site (http://www.doh.gov.uk/haicosts.htm).

17.8 Infection may spread by a variety of routes including patient-to-patient, patient-via-staff and contact with building fittings or furniture previously contaminated by the infectious agent.

17.9 Transmission of infection within a hospital requires three elements to be considered:

- sources of potentially pathogenic organisms;
- susceptible hosts;
- means of transmission.

Sources of potentially pathogenic organisms

The environment

17.10 The environment has been increasingly implicated as a source of infection in the hospital setting and bacteria such as MRSA have been shown to survive in dust and on equipment for long periods.

Hands

17.11 Hand-washing is without doubt the most important intervention in the control of cross-infection and it is important that hospital accommodation is designed to encourage hand washing, see 'Clinical sinks – design for clean hands' in the NHSScotland guidance Scottish Health Facilities Note 30 'Infection control in the built environment: design and planning'.

Patients' own endogenous flora

17.12 This is a difficult area to control and may be addressed by pharmaceutical means. Intravenous administrations can also be implicated in cross infection.

Other human sources of infection

17.13 Occasionally staff, patients and visitors may be a source of infection as they also may be incubating a disease or be colonised with bacteria.

17.14 Inclusion of single bedrooms or small two-bed bays into the design of new build healthcare facilities can help to overcome some of these problems.

Susceptible hosts

17.15 Factors such as age, immune status, underlying disease, certain treatments and breaks in the first line of defence are all possible problems that may render this group of patients more susceptible to infection.

Means of transmission

17.16 Transmission of potentially pathogenic organism occurs by:

- contact, usually staff to patient, either direct or indirect which involves contact of a susceptible host with a contaminated object or the environment;
- airborne transmission – coughing, sneezing, talking or during certain procedures such as bronchoscopy. Droplets containing micro-organisms that remain suspended in the air for long periods of time or dust particles containing infectious agents. Infection spread in this way can be dispensed widely and may be inhaled by susceptible hosts either within the immediate environment or over longer distances. Special air handling or ventilation is required to prevent airborne transmission;
- isolation precautions are designed to prevent transmission of infection in hospital and especially for this patient group during periods of susceptibility; temporary periods of neutropenia.

17.17 During periods when they are not undergoing treatment some patients may have other underlying risk factors such as a break in skin integrity through a Hickman line/CVP, or problems with other metabolic factors such as malnutrition, etc. In these circumstances basic infection control procedures apply in the same way as to any other hospitalised patient.

Preventative measures

Built environment and facilities management

17.18 Exposure to exogenous pathogens should be reduced. This can be assisted by attention to the built environment by providing the following:

- single rooms/small two-bed/four-bed bays with doors;
- space around the beds;
- hand wash facilities;
- staff change areas;
- decontamination facilities;
- design for a clean environment;

- appropriate ventilation;
- suitable furnishing/fixtures, fittings and flooring;
- portable water;
- catering facilities;
- hand wash facilities for patients and visitors;
- reverse isolation/barrier nursing;
- an environment that is easily cleaned and then actually kept clean;
- a high standard of decontamination of equipment/instruments and medical devices, etc.

Specific infection control issues during renovation/refurbishment or construction

17.19 It is important that the infection control team is consulted early in the planning stage of either refurbishment or renovation of existing buildings or in any new schemes for healthcare buildings. For timing of inclusion and areas of consultation see the NHSScotland guidance Scottish Health Facilities Note 30 'Infection control in the built environment: design and planning' .

17.20 It is also important that the infection control team carry out risk assessments for any building work that will take place in patient areas, especially in areas where immuno-compromised patients are looked after, and produce a policy for contractors. Continued monitoring is then necessary and can be achieved by carrying out environmental rounds once the building work is under way.

17.21 General care in design should extend to the avoidance of design elements that promote the accumulation of dirt or microbial growth. Particular attention should be paid to wall, floor and bench surface finishes where care to ensure the absence of discontinuity and promote ease of cleaning is required. This will apply particularly in chemotherapy treatment rooms and minor procedures facilities. Extensive additional information is available in NHS Estates guidance Health Building Note/Scottish Hospital Planning Note 40 'Common activity spaces'.

17.22 Debris arising from building operations or from the breakdown of building materials, including some ceiling tiles, is known to promote infection by some species including fungi such as Aspergillus spp.

17.23 Infection control issues during refurbishment and new build include:

- timely notification and involvement of the infection control team;
- design to support infection control practice, i.e., ventilation, single rooms, hand hand basins, fixtures/fittings/furnishings;
- utility rooms, storage and space;
- dust and debris control, the problems of Aspergillus spp;

- prevention of contamination of patient rooms, ward areas and supplies/equipment;
- impact of work being carried out around at-risk patients;
- interruption of services; ventilation, water;
- water contamination;
- flooring, ie, carpets versus hard floor.

17.24 The spread of infection from hand-to-hand contact is a particular challenge that should be countered by the provision of washhand basins in sufficient numbers, and located so as to promote their frequent use, particularly by staff on wards and in treatment areas. This challenge must not be neglected in specialist areas such as radiotherapy treatment facilities.

17.25 Restriction on the spread of infection should be a design priority in the provision of natural or mechanical ventilation. The reader is referred to the NHSScotland guidance Scottish Health Technical Memorandum 2025 'Ventilation in healthcare premises' .

17.26 The operating theatre is an area of particular concern. Some elements of advice are contained within this document in respect of common cancer-related procedures. Readers are referred to NHS Estates guidance Health Building Note 26 'Operating department together with NHSScotland Scottish Hospital Planning Note 26 'Operating department' for general advice.

Facilities for immuno-compromised patients

17.27 The use of total body irradiation as part of leukaemia therapy and other treatments, with the subsequent need for infection-protective nursing and high levels of precaution against infection with such patients, will be a special concern for some cancer care centres. Patients will be accommodated in individual rooms, often grouped around a common nursing and access area. High levels of nursing supervision and access control are necessary. Facilities must satisfy the requirements of the Level 4 care standard defined by the Clinical Haematology Task Force of the British Society of Haematology.

17.28 The design team must include the control of infection team, specialists in theatre level ventilation systems and a clinical consultant with special interest in this specific patient group.

17.29 The patients' rooms will be subject to special consideration on surface finishes, with very high standards of surface continuity being considered essential. The choice of materials will also reflect the need for frequent disinfection and rigorous chemical cleaning. The selection of furnishing must also be cautious in terms of cleanability, the avoidance of loose fibres and the near total exclusion of environments in which bacteria or fungi may be able to grow.

17.30 Mechanical ventilation, with a micropore filtration system, is necessary and will itself preclude the non-controlled use of natural ventilation. The use of over-

pressure to ensure a constant outflow of air, such as to exclude uncontrolled air leakage into the room will be essential.

17.31 The use of local article sterilisation facilities should be considered.

17.32 Staff will require local dedicated changing facilities to permit the use of theatre standard clothing and very high standards of personal hygiene. Some staff will require scrub facilities.

18. Appendices

Appendix 1:

Specific engineering requirements

Introduction

1. This Appendix describes specific engineering services requirements for Cancer Care Centres. It complements the general engineering services guidance given in Scottish Health Planning Note 03 'General design guidance'. The combined guidance should not inhibit the design solution, but will acquaint the engineering members of the multi-disciplinary design team with the design criteria and material specification needed to meet the functional requirements. Specific requirements should be formulated in discussion with both end-users and manufacturers of specialist equipment. Some issues particularly those related to radiation safety will require specific and detailed discussion with other professional consultants including the local RPA.

Maximum demands

2. Details of power consumption and load patterns of significant individual items of equipment must be sought from manufacturers and/or suppliers. Most commonly this information will be received as part of the equipment tendering process.

3. Estimated engineering loadings etc for one high-energy linear accelerator suite are given below, as a guide and for preliminary planning purposes only.

Earthing for linear accelerators

Recommended – 0.1 Ohms but must not exceed 0.2 Ohms when measured between any point in the system and the main earth reference terminal.

Example: Siemens, Mevatron Linear Accelerator

Mass of machine

- weight of accelerator when installed; 7030 kg;
- heaviest component when being transferred to bunker; 4082 kg.

Power requirements

- typically 480V or 380V preferred to 240V source when available;
- three-phase delta to star at 50/60Hz with +/- 1Hz frequency variation permitted;

- power use or requirements; 30kVA;
- typical system input voltage; 240V line to line, 120V line to neutral;
- line voltage variation, +/- 10% maximum;
- phase balance, 2% between 2 phases;
- line impedance <= 0.050 Ohms maximum line to neutral at secondary of transformer;
- surges and sags 10% above and below line voltage, 20msec maximum duration;
- high frequency noise, no single event greater than 10V in the range 10kHz and 2MHz;
- spikes, no single event greater than 100% of the nominal line to line voltage expressed as peak voltage; 240 peak for 240V input;
- typical circuit protection, 80Amps.

Heat dissipation into air

- 13,989 BTU/hour when operated or 14kW/hour approximate;
- 6,824 BTU/hour when in standby or 6.9kW/hour;

Noise at 1m distance

- 75dB(A); maximum value;

Room temperature requirements

- no condensation;
- room temperature not to exceed 26°C and 65% relative humidity;
- atmospheric pressure, treatment room must not differ by more than +/- 250mbar when compared to control area.

Air filtering

- class EU 4 (B2) and observe German standard DIN 1946.

Room air changes

- the air-conditioning should be capable of at least seven air changes per hour to allow for a maximum duty cycle of 15 minutes per hour and an ozone concentration of less 0.05ppm.

Accelerator water supply

- closed-loop chiller water system;

- water temperature, 10°C minimum, 25°C maximum;
- flow rate, 30l/minute at 25°C;
- dissolved solids in facility water cooling system must not exceed 0.01%;
- heat dissipation to water, typical consumption, inlet temp of 14°C and patient load of six per hour would use between 2 and 4 litres/minute;
- direct mains water for cooling must not be used, cooling water should be recirculated.

Physical distance between cables

Standard cabling length from control console/accelerator interface is 24m and allowance must be made 3m from conduit exit point to the interface on the linear accelerator or control console. Maximum conduit length is 18m.

Example: Varian Oncology Systems, Dual Energy Clinac

Mass of machine

- 17,508 kg when installed;
- largest component; 4,240kg when moved onto bunker.

Power requirements

- Dual Energy Clinac – 45kVA;
- typical international requirements, 360 to 440VAC 50/60Hz line to line, three-phase supply four wire plus ground star configuration, line voltage regulation +/- 5.

Heat load

- 12kW per hour.

Note: These examples are typical at the time of writing but due to the rapid rate of change in technological requirements care is advised. Several additional suppliers also provide linear accelerators to the NHS.

Activity data

4. Environmental and engineering technical data and equipment details are described in the relevant Activity Database, available from NHS Estates as a subscription service. This should be referred to for space, temperatures, lighting levels, outlets for power, telephones, equipment details, etc. Significant gains in both management and patient service areas may be expected from the provision of a wide-bandwidth LAN and associated computing equipment. This is especially true in the areas of radiotherapy and some parts of diagnosis and

treatment planning. Also refer to NHSScotland guidance Scottish Health Planning Note 03 'General design guidance'.

Safety

5. The Ionising Radiation (Medical Exposure) Regulations 2000 and the associated Codes of Practice place onerous requirements upon engineering aspects of design and operational practices in cancer care centres and units. Over and above this, there are additional requirements in the 1993 Radioactive Substances Act with respect to storage, use and disposal of radioactive materials. The local radiation protection adviser (RPA) and custodian of radioactive substances must be consulted.

Environmental requirements

6. Detailed environmental requirements for specialist equipment relating to this accommodation should be obtained from manufacturers. The comfort of patients and staff should be considered in respect of temperature stability and the effects of waste heat derived from high-powered diagnostic or treatment systems. Humidity control is often a key feature of successful design.

Space for plant and services

7. It should be noted that machine plant rooms are required for each accelerator. These should be structured such that plant for one accelerator can be isolated without affecting operations of any other. Similarly, it should be possible for engineering staff to work, under an approved 'Permit to work' system, without any hazard to themselves by the operation of other accelerators.

8. All mechanical and electrical services entering rooms potentially containing radiation must be routed through specially designed access ports so that shielding is not compromised. It may also be necessary to design-in changes in direction of ductwork, and cable containment systems to provide protection against radiation breakout, services into linear accelerators will all pass through the maze, with possibly an additional chicane for high-energy linear accelerators.

9. In other situations, existing installations for example, services may pass into the room at low level and rise into their final position. The precise arrangements will be project specific and should be determined with the installation specialist.

10. In a diagnostic or treatment simulation area the access arrangements must not compromise the radiological protection provided for these rooms. Consideration should be given to the comfort as well as safety of patients and others. It may be appropriate to use a 'double knock' system whereby attempted unauthorised access first initiates an audible warning and only when the access attempt is continued is radiation-emitting equipment switched off. However, the hazard

levels present with therapy equipment require a more stringent approach in which any intrusion will trigger beam shutdown.

Engineering commissioning

11. The services for linear accelerators may require to be commissioned early in the engineering contract programme. This is to ensure that the linear accelerators commissioning is completed prior to the first patient arriving. Parts of this commissioning are concerned with radiation safety and the approval of the local RPA must be obtained for the processes and schedules used.

Mechanical services

Heating

12. Special care is needed when radiators are installed in rooms where unsealed or liquid radioactive sources are used. Protection of such fittings against radioactive contamination will be essential.

13. In calculating heating requirements care must be taken to include heat yield from high-powered equipment used in cancer care centres.

Ventilation

14. The majority of the areas within the facility will require mechanical ventilation, due to equipment heat gains, patient/staff numbers and clinical/radiology reasons.

15. The supply plant for ancillary accommodation should be separate from plant serving the cancer care facility.

16. Fume cupboards and microbiology cabinets will be required and their exhaust locations will need careful consideration. These items are used for a range of specific containment tasks such as dealing with cytotoxic drugs or radioactive materials. Equipment types and installation requirements will vary significantly with the application and hazards involved. Detailed local advice must be sought from the appropriate scientists and pharmacists.

17. Consideration should be given, in discussion with the user, regarding the possible use of aromatherapy via the centre ventilation system. This may be effective as an environmental enhancement and there is some limited evidence of particular benefit to this patient group. The smell-masking produced may also be of value.

Ventilation of therapy rooms and bunkers

18. Due to the excessive heat emission from some equipment such as linear accelerators, etc., and the special and often prolonged nature of the

procedures, mechanical ventilation will be a requirement to achieve the required air changes. It is possible that they may also require that the air supply to these rooms be mechanically cooled. Discussions should take place between the users, manufacturers and engineers to ensure an appropriate temperature is achieved. Where deep planning of other continuously occupied spaces, for example offices, is unavoidable, there will also be occasions when acceptable levels of comfort can only be maintained by air-cooling.

Ventilation of pharmaceutical services rooms

19. Details of specialist ventilation of pharmaceutical departments are included in NHS Estates guidance Health Building Note 29 'Accommodation for pharmaceutical services', which can be used with general caution in Scotland. However, the use of cytotoxic drugs in chemotherapy generates an additional series of considerations. These include the need to effectively control toxic fumes and the prevention of environmental contamination. Specially adapted microbiological safety cabinets and other containment devices will be needed. Discharge filtration will be applicable in the majority of instances.

Ventilation controls

20. Supply and extract ventilation systems should include local controls and indicator lamps to confirm the operational status of each system. Where the system is used in a regular daily pattern, timeswitch control with manual override for a limited period should be considered, staff-controlled boost ventilation for a linear accelerator after some patient treatments where the control of odours may be important. The indicators for a system serving a particular space should be in or immediately adjacent to that space. It may be appropriate to locate all indicators at the staff base. Where manual controls are available for staff use, they should be provided with labels that clearly define their function. Such manual controls are more likely to be needed in cancer care because of the need to clear odours generated by some types of tumour. Local consultation with healthcare professionals is advised.

Ventilation filtration

21. Ventilation supply plant should include air filters having a minimum arrestance of 85% when tested in accordance with BS EN 779. In urban or other areas of high atmospheric pollution, a higher standard of filtration may be economically justified to reduce the level of staining to internal finishes. Filters must be readily accessible for replacement and should be provided with a pressure-differential indicator.

Ventilation of isolation rooms

22. The facility may require isolation rooms to protect patients and/or staff. Guidance should be sought from the project team or end user.

23. The mechanical ventilation system for isolation rooms should be designed to provide either a 'source' or 'protective' isolation non-changeover system that provides balanced supply and extract ventilation to each room and a gowning lobby is recommended. A 'constant mode' system has a number of advantages and avoids the complications and reliability problems associated with changeover systems.

24. The gowning lobby, which functions as an airlock, will require a relatively high and balanced supply and extract air change rate to be effective against airborne organisms moving between circulation areas and the rooms. For this reason, the gowning lobby should be relatively small.

25. Staff entering the gowning lobby from the corridor will go through a clinical hand-washing procedure and during this period, the ventilation system will dilute the air entrained from the corridor. Further entrainment and dilution occurs as staff move from the gowning lobby to the room. The amount of air and number of organisms transferred from the corridor to the room through this process should be exceptionally low and will be inversely proportional to the time spent gowning up. The reverse will also apply as staff leave the single bedroom.

26. The mechanical ventilation system should also include mechanical cooling and provide for a range of temperatures which can be adjusted by staff. The humidity within the single room should also be controlled.

Piped medical gases and vacuum

27. Guidance on piped medical gas systems, anaesthetic gas scavenging and gas storage is contained in NHSScotland guidance Scottish Health Technical Memorandum 2022 'Medical gas pipeline systems'. There is a high likelihood that such services will be needed in selected treatment rooms. Local consultation is essential.

27 Special non-ferrous fittings will be needed if equipment may also be used in MRI scanning rooms.

Bedhead services

28. Depending on the type of care being provided, it may be desirable to provide a more domestic environment. To achieve this, bedhead services can be concealed within a cupboard or behind some other movable feature. However to enclose such services requires care to ensure that there is adequate ventilation in the event of gas leakage. Sufficient space must be provided. Current clinical practice is to leave devices permanently inserted into medical gas outlets and plugged into electric sockets.

Lighting

29. Emergency lighting of control rooms should also be arranged in accordance with the requirements of users and NHSScotland guidance Scottish Health Technical Memorandum 2011 'Emergency electricity services'.

Electrical interference

30. Care should be taken to avoid mains borne interference, electrical radio frequency and telephone interference affecting physiological monitoring equipment, computers or other electronic equipment used in this accommodation. Special care requires to be taken with dosimetry, IT and CCTV cables, which should be accommodated individually to prevent any problems.

Lighting treatment rooms

31. An examination luminaire should be provided over the treatment chair/table. It should be adjustable in pitch and rotation to allow the beam to be directed locally. Reasonably shadow-free illumination, with negligible heat development, should be provided to avoid injury to patient and staff. The examination luminaires should be manufactured and tested in accordance with the requirements specified in the relevant sections of BS 4533.

32. For linear accelerators and some other treatment machines, automatic switching to low-level room lighting will be needed to facilitate the use of field marker lights and low-power alignment lasers. Conversely, high levels of lighting are needed for equipment maintenance.

Illuminated signs

33. At each entrance to a radiodiagnostic or radiation treatment room, a safety sign and a warning lamp must be provided in order to comply with the statutory requirements for radiological protection. The warning lamp must give a clear indication in red when it is energised and may incorporate the legend "do not enter", visible only when illuminated. All warning lamps should have incandescent filaments energised from a suitable power source within the room and switched via appropriate devices interlocked with the operation of the diagnostic or therapeutic equipment.

34. Other illuminated signs may also be required within the facility. All such signs should be connected to essential supplies where necessary. For therapy equipment, where exclusion of persons other than the patient is essential, the warning systems must work with interlocks and be specifically approved by the local RPA.

Socket outlets and power connections

35. Socket outlets in areas for consultation, examination or treatment and wherever X-ray films are processed, reported on or stored, should be connected such that within each area a supply is available from at least two separately fused circuits of the same phase.

Electrical supplies to diagnostic and therapy equipment

36. Advice on the power supply and requirements for fixed and mobile radiodiagnostic equipment is contained in NHSScotland guidance Scottish Health Technical Memorandum 2007 'Electrical services: supply and distribution'. Individual project requirements should be discussed at an early stage with manufacturers and suppliers of equipment.

37. The earth connection at the power termination should be suitable for the functional earth requirements specified by the radiology equipment manufacturer, and be arranged to receive a direct connection from the earth reference terminal which should be provided or designated in every radiodiagnostic room. Further guidance on the purpose, characteristics and performance criteria of an earth reference terminal are given in NHSScotland guidance Scottish Health Technical Memorandum 2007 'Electrical services: supply and distribution'.

Staff location system

38. The hospital staff location system should be extended to include this facility. Further guidance is contained in NHSScotland Scottish Health Planning Note 03 ‘General design guidance’. There are particular advantages to the use of such systems in cancer care. Patients’ groups have emphasised the value in continuity of contact with a familiar care team and individual members of staff.

Patient/staff and staff/staff call systems

39. Particular care will be required in choosing and siting call units for use whilst a patient is undergoing treatment, for example, within a linear accelerator.

Telephones

40. At least one ex-directory line should connect directly with the local ambulance services control centre, depending on local policy. It should have a distinctive bell or buzzer.

Intercom systems

41. The character of the diagnostic techniques used within cancer services may make it appropriate to provide intercom stations in addition to the telephone and call systems. These permit ‘hands-free’ speech contact, staff/staff, patient/staff

or staff/patient. Consideration should be given to the local circumstances and treatment methods.

CCTV

42. CCTV should be provided, where required, to monitor patients undergoing treatment in restricted areas. The interference to which such equipment may be subject should be taken into account when it is specified to ensure acceptable electromagnetic compatibility. Care should be taken in the positioning of monitors in order to preserve patient privacy.

Music and television

43. Conduits for television/video and background music system outlets should be provided to public areas, bedheads and treatment rooms.

44. The provision of an independent or independently controlled music distribution system from the rest of the hospital should be considered in light of local patient needs.

Chemical and radioactive contaminated effluent

45. Providing that there is adequate dilution and the silver content has been effectively recovered, effluent can be discharged into the internal drainage system. Project teams are advised to establish the acceptable levels for silver and other processing chemicals at the planning stage of a scheme, as these are subject to change.

46. The drain from the toilet and shower associated with the diagnostic room where nuclear medicine imaging is undertaken will carry slightly radioactive effluent. It must be sealed throughout its run to the main sewer and its route chosen with regard to the areas likely to be affected if leaks develop. It is recommended that drainage for this purpose should not be into a pumped system.

47. At an appropriate early stage in the design process the project proposals for the collection and discharge of chemical and radioactive contaminated effluent should be discussed and verified with the local authority. Some local authorities may impose restrictions on the quantity and rate of discharge of such effluent into public sewers. Refer to the section within this guidance on environmental protection.

Appendix 2:

Room layouts

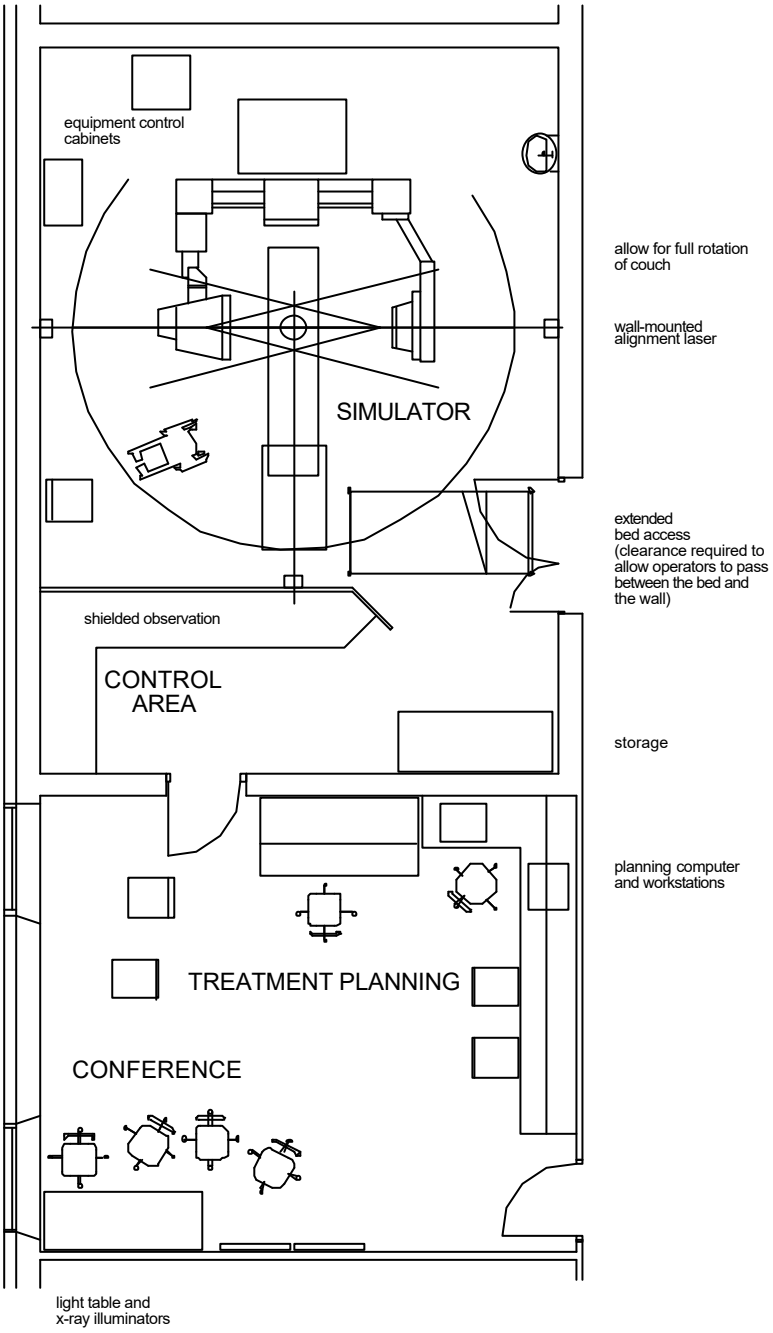


Figure 1: **Simulator with treatment planning and conference suite**

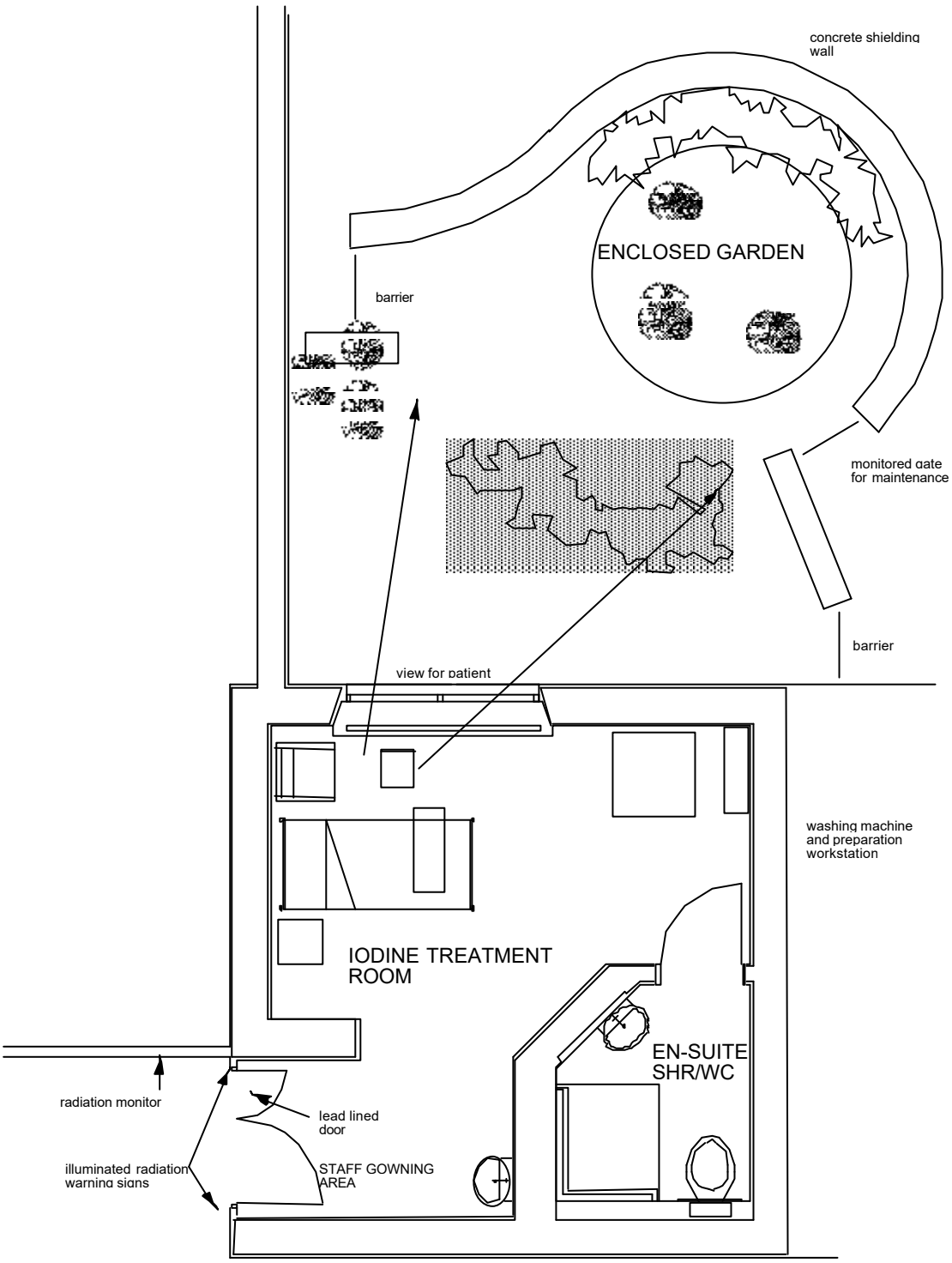


Figure 2 : **Iodine treatment room with ensuite shower/WC**

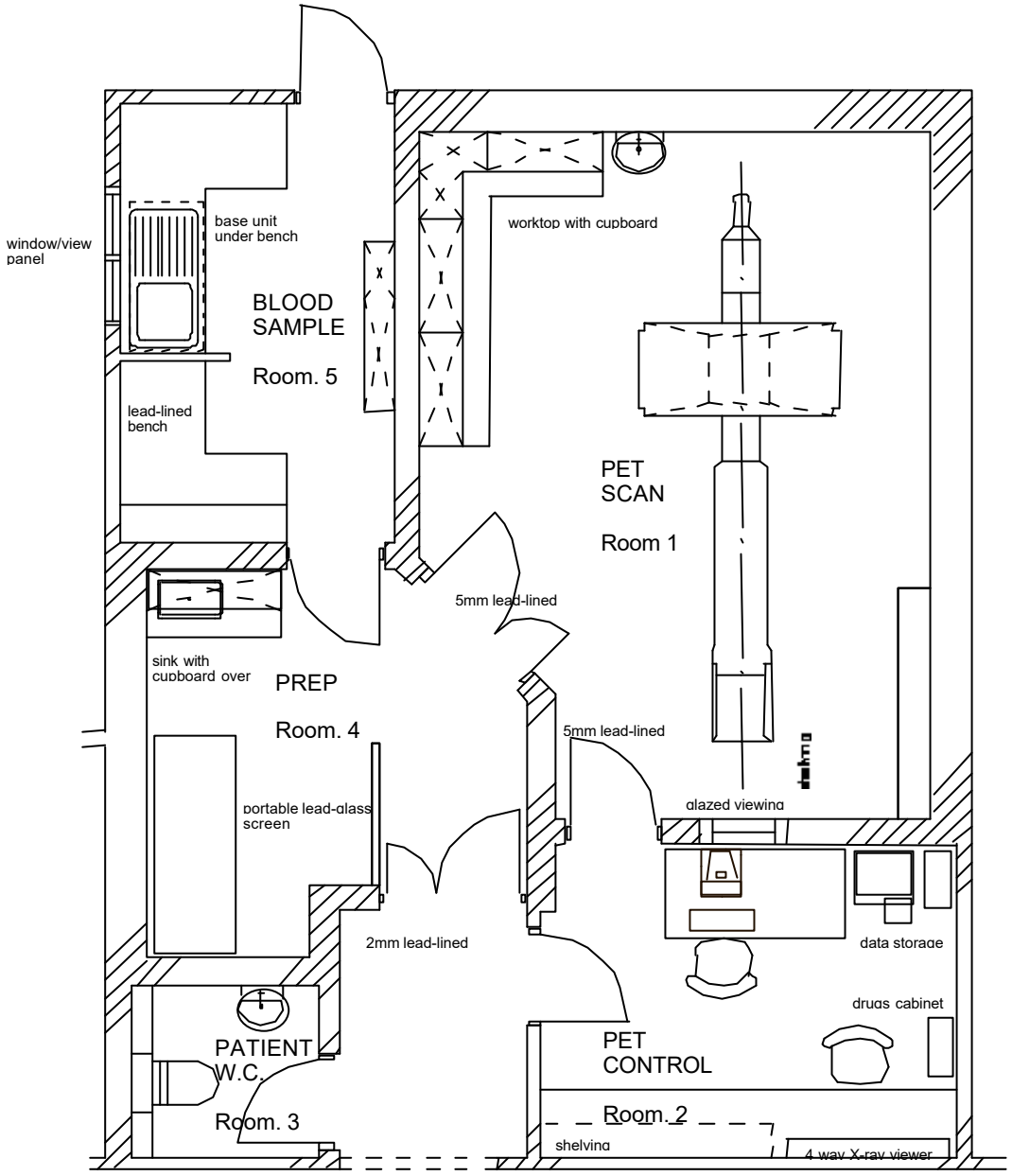


Figure 3: **A typical PET suite**

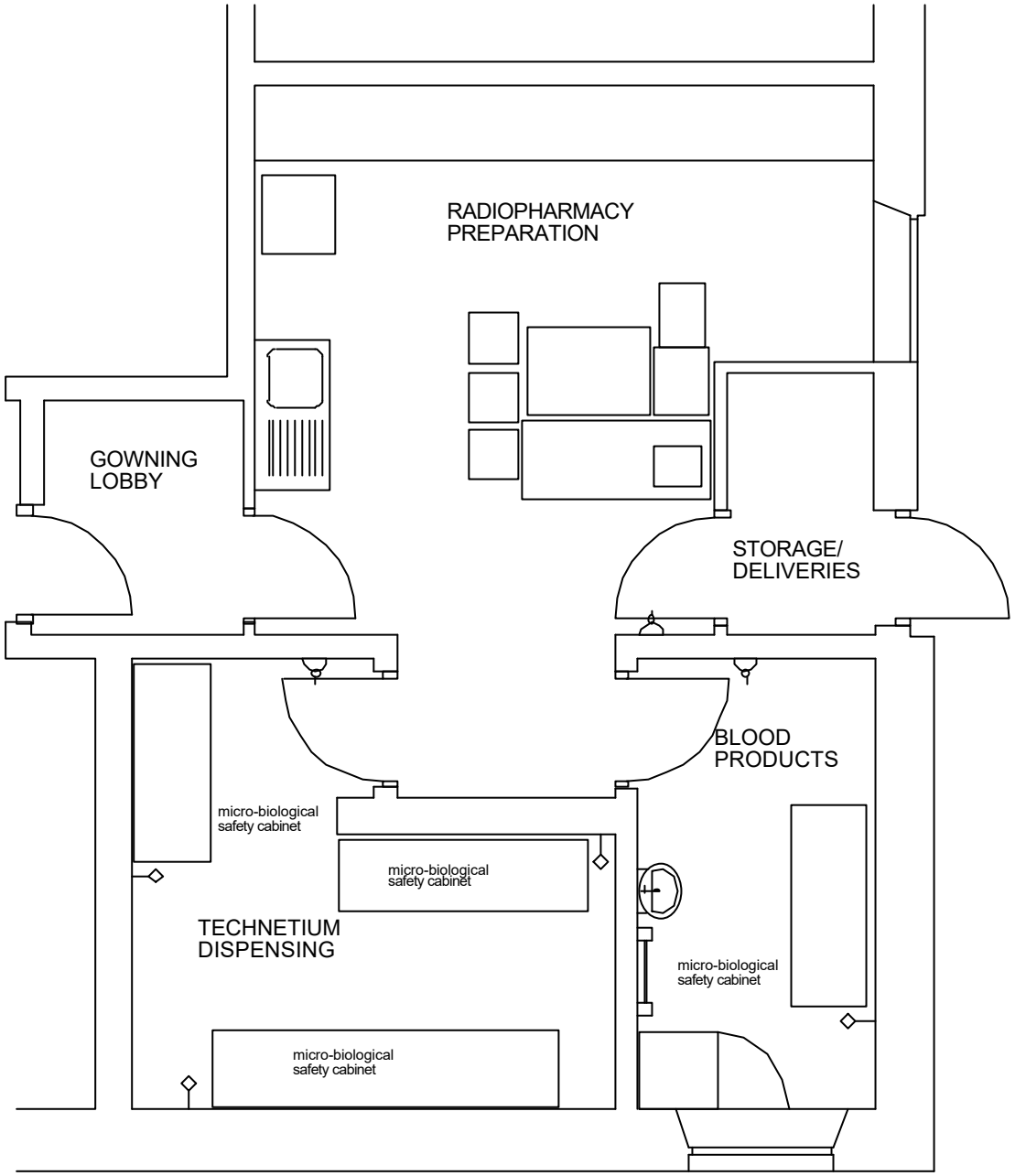


***Figure 4*: Example layout radiopharmacy suite.**

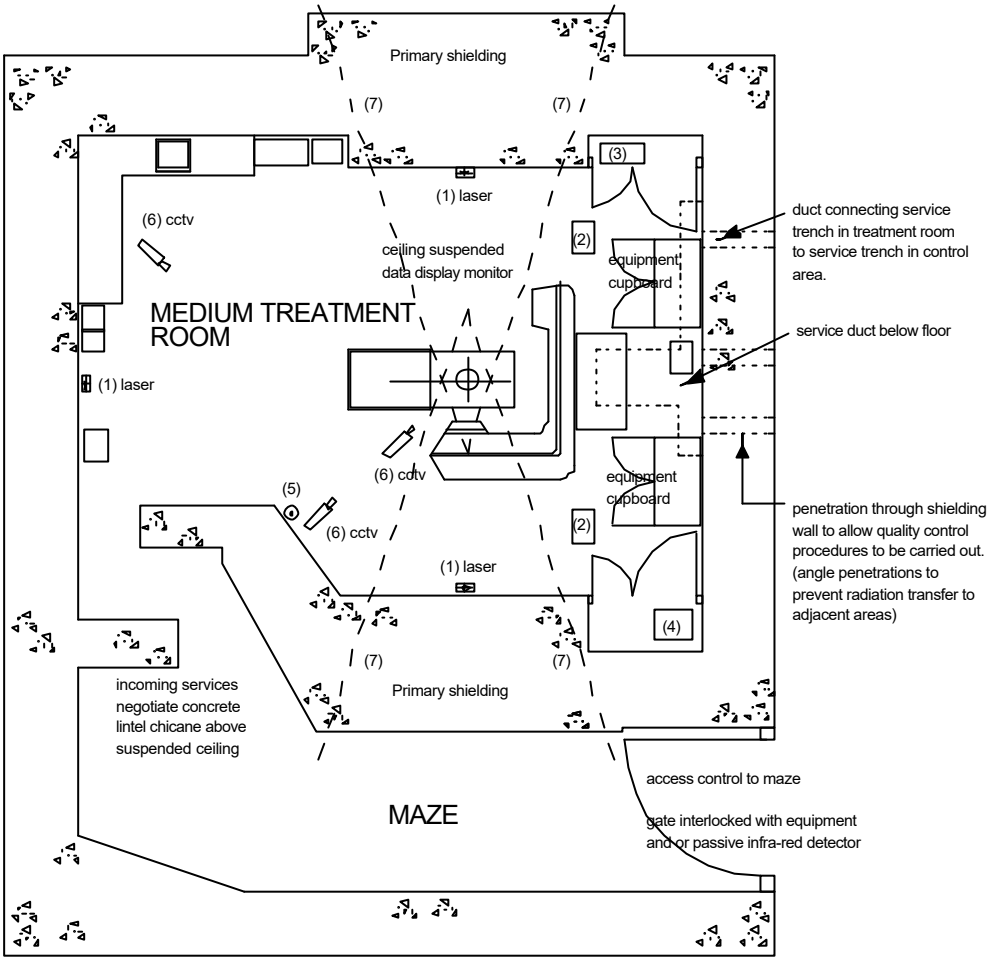


Figure 5: **Example layout of medium-energy accelerator treatment room**

1) Laser alignment light rigidly mounted to structure and connected to laser generator using fibre optic cables.
2) Data monitor.
3) Laser generator.
4) Stabiliser.
5) Last person out button.
6) CCTV patient monitoring cameras, fixed focus and/or patient zoom.
7) Primary beam and intermediate scatter cone.

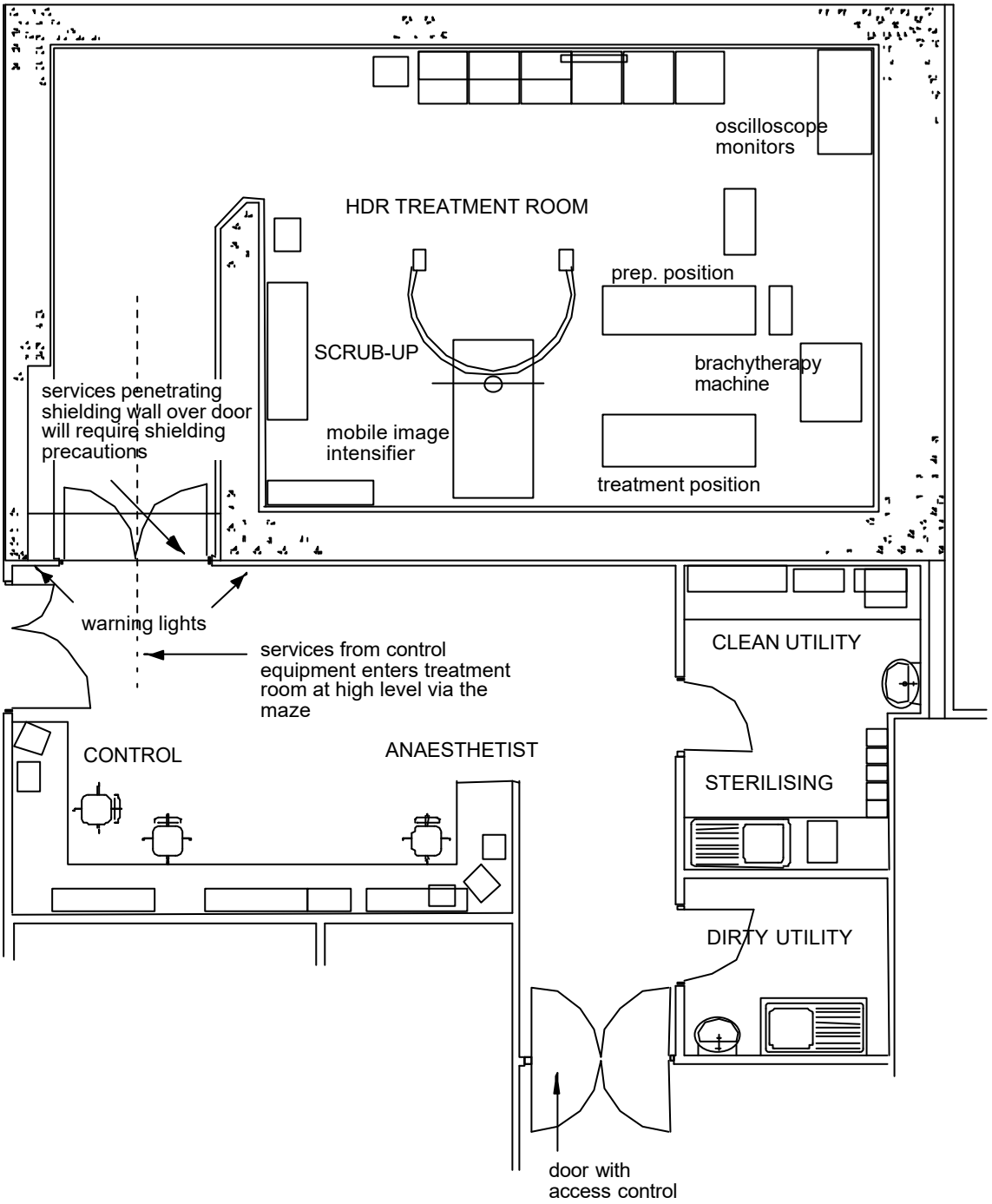


***Figure 6*: Example layout of high-dose radiotherapy suite**

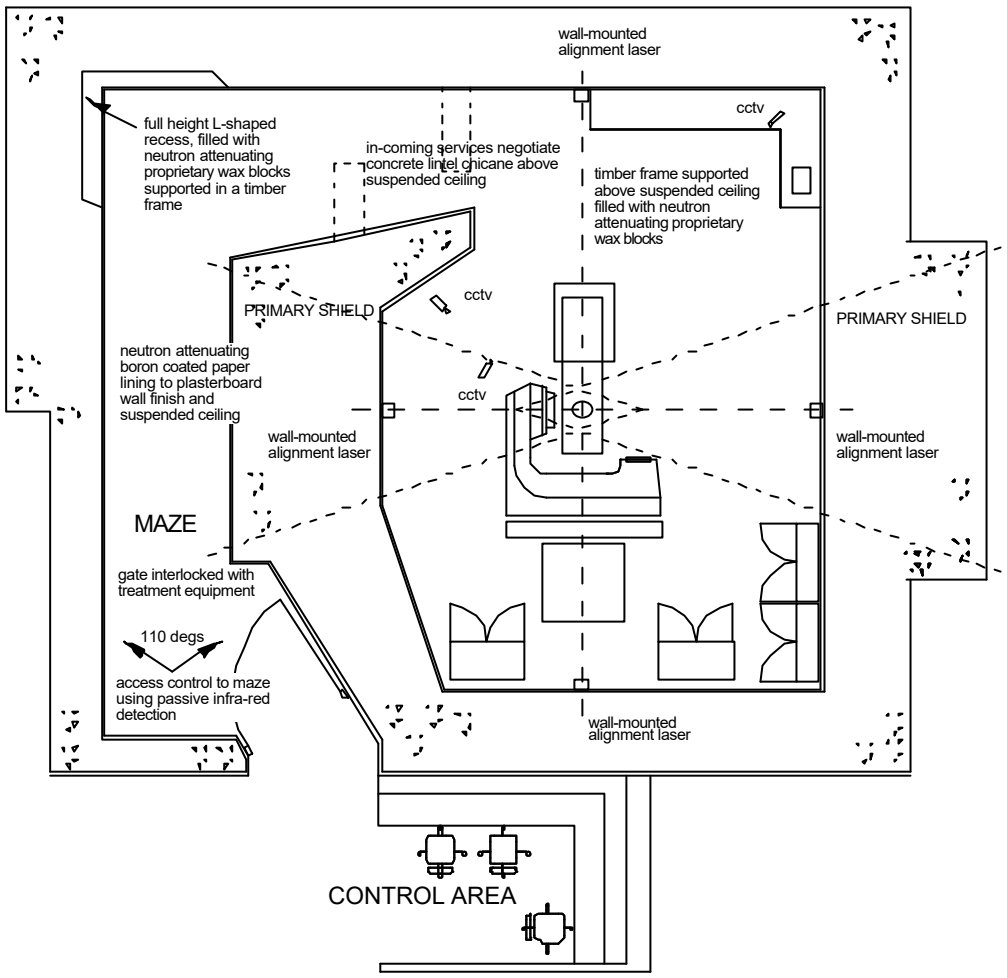


Figure 7: **Example layout of high-energy linear accelerator treatment room**

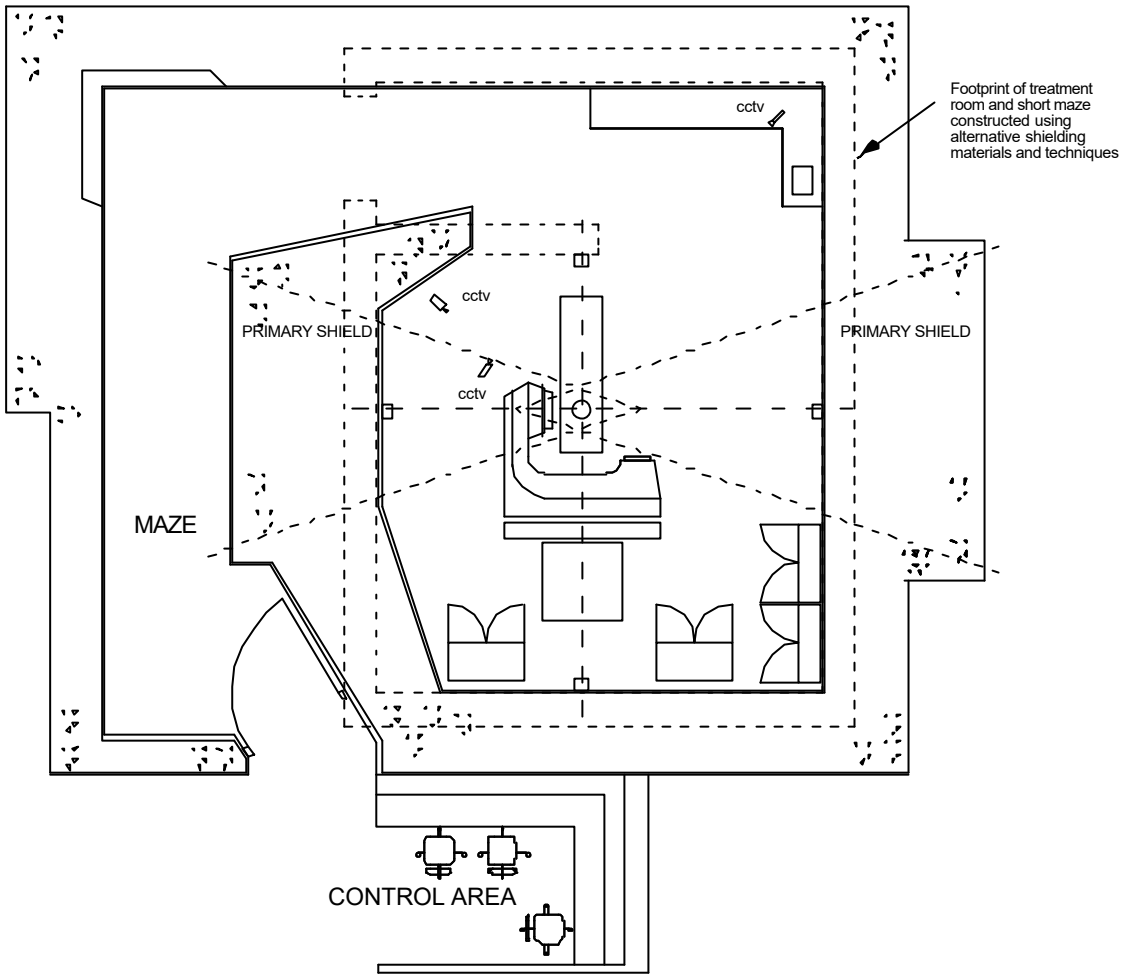


Figure 8: **Example layout showing comparison between footprints of high-energy linear accelerator rooms constructed using concrete shielding walls and alternative proprietary shielding material**

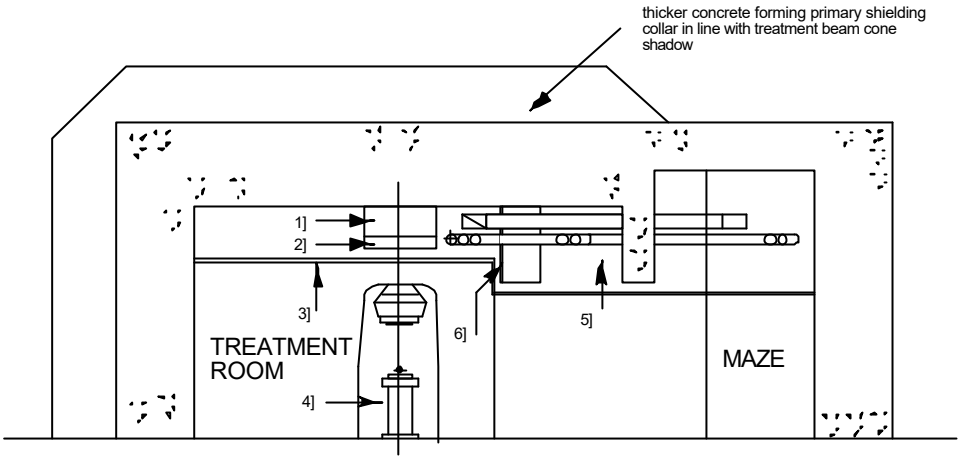


Figure 9: **Cross-section through treatment room and maze showing shielding chicane and entry for services**

1) Lifting beam over treatment machine.
2) Wax block neutron attenuation supported in timber cradle.
3) Suspended ceiling. **N.B** access required to lifting beam during equipment installation and maintenance, lifting eyes required attached to concrete soffite behind line of machine gantry.
4) Treatment machine and patient couch.
5) Services negotiate concrete downstand 'chicane' as they enter treatment room.
6) Downstand faced with wax neutron attenuation.

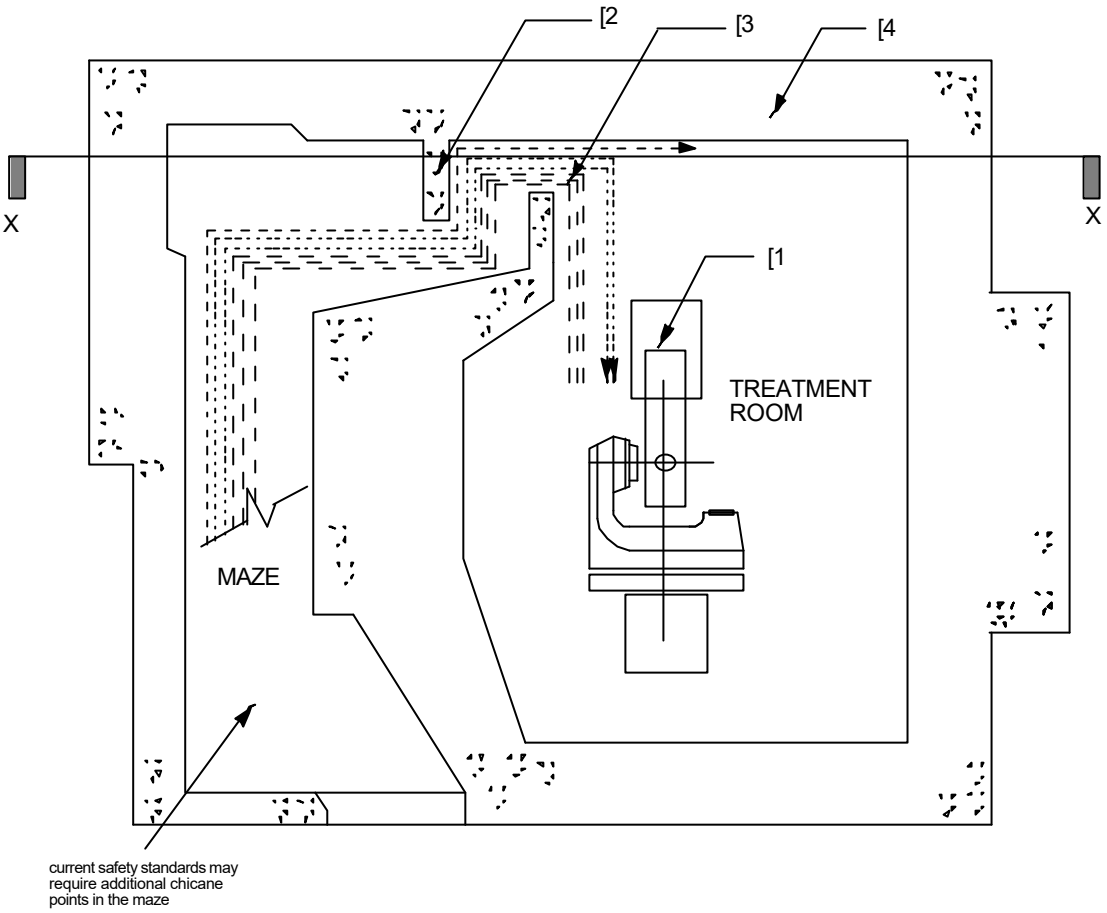


Figure 10: **Plan of treatment room and maze at ceiling void level. Showing diagrammatic service route along maze passing through shielding chicane and into treatment room**

1) Wax block neutron attenuation supported timber cradle.
2) Concrete downstands (faced with wax block neutron attenuation).
3) Services negotiate downstand 'chicane' as they pass into treatment room.
4) Concrete shielding walls.

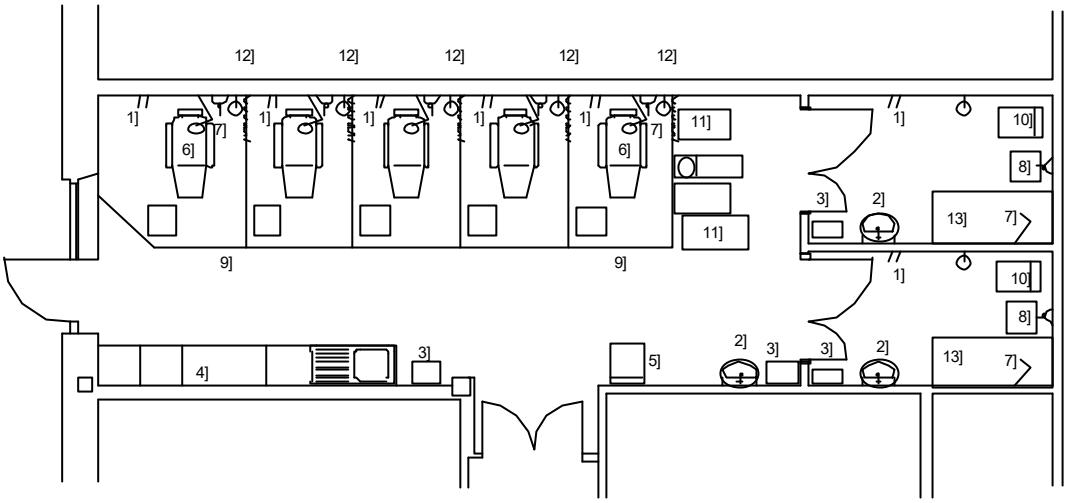


Figure 11: **Example layout of chemotherapy treatment day space showing combined shared space and single patient rooms**

1) Coat hooks
2) Clinical hand wash basin
3) Sack holder
4) Worktop
5) Easy chair
6) Reclining chair
7) Examination light and services
8) Bedside locker
9) Cubicle curtain track
10) Easy chair
11) Trolley
12) Curtains
13) Bed

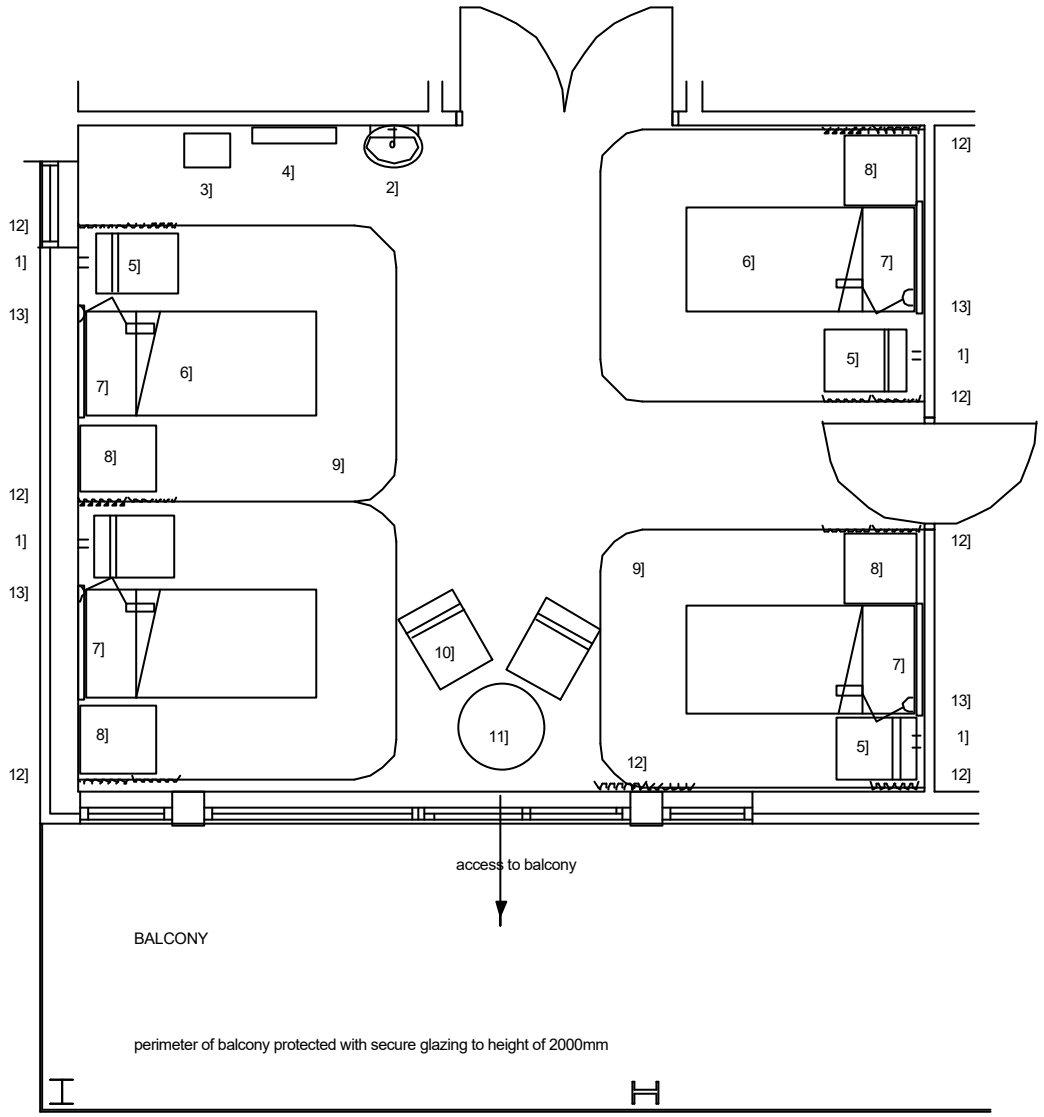


Figure 12: **Example layout of chemotherapy treatment space for four patients using beds**

1) Coat hooks
2) Clinical hand wash basin
3) Sack holder
4) X-ray viewer
5) Easy chair
6) Bed
7) Chinagraph board
8) Bedside locker
9) Cubicle curtain track
10) Easy chair
11) Coffee table
12) Curtains
13) Television

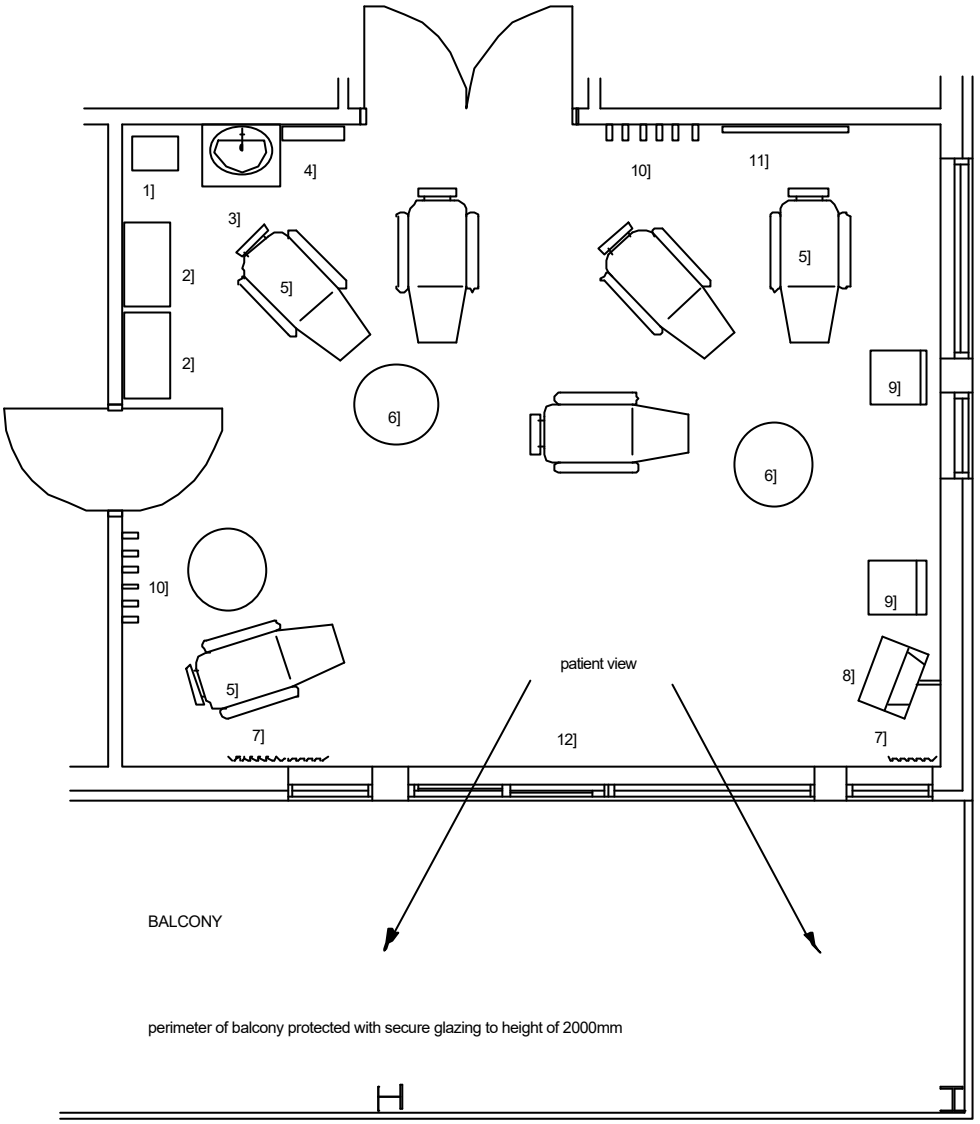


Figure 13: **Example layout of chemotherapy treatment day space for six patients using reclining chairs**

1) Sack holder
2) Dressings trolley
3) Vanity Unit
4) Wall shelf
5) Reclining chair
6) Circular table
7) Curtains
8) Wall mounted television
9) Chair
10) Coat hooks
11) Notice board
12) Sliding doors with access to balcony

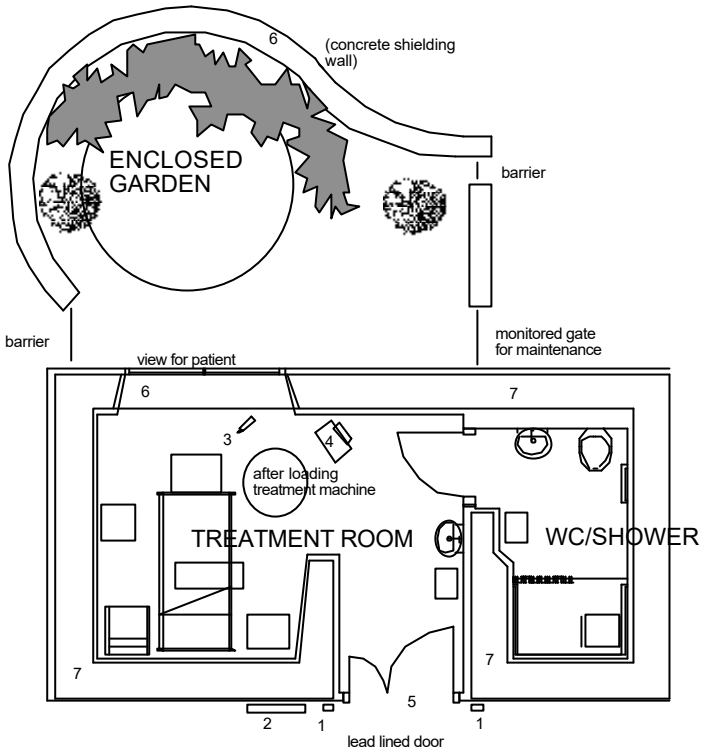


Figure 14: **Brachytherapy treatment suite with en-suite shower/wc**

1) Radiation monitor at entrance.
2) Control panel for after-loading treatment machine.
3) CCTV patient monitor.
4) Ceiling mounted TV.
5) Lead lined doors with access control.
6) Windows can be included if alternative radiation protection is provided. In this arrangement, an external garden area was created with concrete shielding walls.
7) Enclosing structure constructed from concrete 450mm thick. Job specific advice should be obtained from the Radiation Protection Agency.

Note: After-loading equipment uses compressed air during the treatment process. Suitable accommodation will be required to afford sound attentuation and access for routing maintenance.

Appendix 3:

Fire safety in radiotherapy treatment rooms

Background

1. For the majority of rooms within a cancer care centre the fire risks and precautions will not differ from other similar rooms within a hospital. However a special case is identified for radiotherapy treatment rooms.

2. Linear accelerator bunkers may potentially be a seat of fire. Clearly the linear accelerator itself employs high-tension electricity so that the potential for electrical fire exists. The figures on the extent of risk are significantly variable from country to country and it is difficult to give a clear quantitative view at this time.

3. The design of the engineering services should comply with the recommendations of NHSScotland guidance 'Firecode', which includes Scottish Health Technical Memoranda 81, 82 and 83. Design guidance for fire precautions in new hospitals is contained in Scottish Health Technical Memorandum 81 ‘Fire precautions in new hospitals’. Technical information concerning the design and specification of fire alarm and detection systems is contained in Scottish Health Technical Memorandum 82 ‘Alarm and detection systems’. This Scottish Health Technical Memorandum replaces or modified certain clauses of BS 5839 Part 1 to meet the needs of healthcare buildings. More general advice on fire safety in healthcare premises is contained in Scottish Health Technical Memorandum 83 ‘Fire safety in healthcare premises’.

Fire compartments

4. Despite some concerns over operational efficiency, NHSScotland recommends the use of 30-minute fire resisting doors to FD30 standard at the entrance to linear accelerator bunker maze structures. The intention is to restrict the spread of both fire and smoke. However, a special problem arises since the Codes of Practice constructed under Ionising Radiations Regulations require that some form of access control or warning device be used at the entrance to linear accelerator bunkers. Commonly, in order to avoid delays in terms of radiographers moving in and out of these specialist rooms, the Code of Practice requirements are met by the use of a light or infrared beam connected to both a warning system and linear accelerator beam control. Clearly such an arrangement will be more difficult, though not impossible, if fire protective doors are employed. This requirement should be discussed with the local RPA.

5. The use of smoke or fire detector-actuated fire door self-closing devices are considered helpful. Fire dampers should also be incorporated into the service duct or other penetrations which enter the treatment room.

Means of escape

6. With a single entrance, dead-end conditions apply in all linear accelerator bunkers. This has important safety implications and places a premium on fire prevention, detection and control. In certain cases the maximum single direction travel distance permitted by the Scottish Building Regulations will be exceeded. In these cases a Relaxation application will be required. The following specific precautions should be incorporated:

- the fire loading within the bunkers is to be kept to a minimum (see 'fire loading');
- automatic fire detection should be provided (see 'fire alarm system');
- the walls and doors separating the bunker from the adjacent accommodation must meet the half-hour fire-resisting standard and should be to FD30S standard and fitted with effective self-closing devices;
- in order to assist in the rescue of patients in the event of a fire occurring, it is recommended that a smoke reservoir be created in the ceiling void above the bunker where feasible. This has significant design implications where radiation baffles are used but the determined false ceiling height will be 3.1m with a door height of 2.1m. The space created may be usefully adapted. The elevated internal ceiling height forming a reservoir, that is to the concrete or Ledite shield above, is likely to be an advantage in terms of radiation protection and the reduction of radiation dose rates in the accompanying maze. However this should be referred to the local RPA;
- the circulation space outside the bunkers must be maintained free of combustible materials.

7. The construction of linear accelerator bunkers in reinforced concrete using supplementary steel shielding, where necessary, is a common and accepted practice. However, there is now a movement toward the use of new materials including Ledite. Some of these alternative materials lend themselves to design changes, which include the provision of heavy shielding doors as a partial but not complete replacement for the provision of a maze. Where this is the case, clearly the fire protective nature of these doors will require evaluation. These heavy doors are generally power operated therefore consideration must be given to their 'fail safe' arrangement in the event of power failure and/or fire. This will require to be considered in conjunction with radiation protection.

Fire loading

8. Consideration should be given to the minimisation of fire loading or available fuel in these environments. Attention is drawn to the following points:

- wax or plastic blocks are used in some locations, not necessarily corners, to absorb particular radiations, specifically neutrons. Such radiation protection measures are only necessary in linear accelerator installations where X-rays are produced at energies of roughly 10MV and above. Accordingly, the use of these materials will not be encountered in the majority of linear accelerator installations. Consideration should be given to encasing these materials within removable plasterboard or other fire-resistant cladding. The performance of individual cladding solutions has not been evaluated at the time of writing;
- the equipment will frequently use oil insulators and may be heavily greased;
- benches are frequently constructed in wood and may support linen, plastic and polycarbonate shells and other combustible materials. The use of enclosed cupboards is most helpful in this and other regards.

Fire alarm system

9. A fire alarm system conforming to BS 5839: Part 1: 1988 and the NHSScotland guidance Scottish Health Technical Memorandum 82 'Alarm and detection systems', must be installed throughout the linear accelerator suite.

10. Each manual call point must be boldly indicated by a notice to clearly identify the fire alarm operating point and conform to the Health and Safety (Safety Signs and Signals) Regulations 1996.

11. An analogue addressable, automatic fire detection system comprising smoke and heat detectors as appropriate should be installed throughout the proposed suite. Positions for the detectors will be dependent on the ceiling layout and compliance with the British Standard.

12. The alarm and detection system should also include the ceiling voids and should be integrated with the existing hospital alarm system in accordance with the NHSScotland guidance SHTM 82 'Alarm and detection systems' and local hospital policy.

13. In respect of degradation of components within fire and smoke detectors, these units will have a shorter life within the linear accelerator bunkers than may be the case in other environments. The effect is at its most significant if the detectors are placed within the belt of heavy radiation protection shielding that encircles the linear accelerator in such a way as to capture the primary or direct beam. The life of these units or components will be very much better if fire and smoke detectors are positioned outside the area irradiated by the primary beam. Further, a few instances of false alarms have been recorded due to the irradiation of smoke detectors by the primary beam of linear accelerators.

Emergency lighting

14. In addition to the normal lighting, an electrical emergency lighting system must be installed, capable of illuminating all exit signs, doors, the maze and treatment room interior. In addition this must cover corridors and all such routes of egress including the external routes to safety. The installation should comply with the NHSScotland guidance Scottish Health Technical Memorandum 2007 'Electrical services supply and distribution' and the British Standard Code of Practice 5266: Part 1:1988.

Indication of fire exits

15. All exits providing access to means of escape must be clearly indicated, as appropriate, by suitable signs that should be positioned where they can be seen clearly.

16. The signs should take the form of a pictogram with the words "fire exit" and where appropriate incorporate a directional arrow. Fire safety signs must comply with the relevant requirements of the Health and Safety (Safety Signs and Signals) Regulations 1996.

Fire fighting equipment

17. The use of fire blankets within the linear accelerator bunker is seen as particularly valuable since these are especially direct in terms of their action.

18. The installation of carbon dioxide fire extinguishers is required for linear accelerator bunkers. However, where these are used, they should be installed outside the area irradiated by the primary beam of the linear accelerator, particularly if this is of the high-energy type operating above the 10-12MV thresholds mentioned earlier. Extinguishers should be mounted on brackets, fixed securely to the walls or other upright structures, so that the top of each one is approximately one metre above floor level.

19. Inert gas fire suppression will be used within the equipment housing or an equipment room. In the former case this would require that the machine have a seal with controlled leakage in order to achieve 10 to 20% gas concentration.

20. The use of multi-criteria interlocked inert/fire suppressive gas extinguishant system in the treatment room and supporting 'machine/modulator' rooms should be evaluated. Such systems may use Argonite or FM 200. In the selection of extinguishing agent care must be taken to avoid corrosive gas options in view of the high value of the treatment equipment. This measure gives an equipment protection option but is not specifically thought to benefit patient or staff fire protection and thus is not adequate used alone.

21. Some new systems use directional inert/fire suppressive gas techniques. Although automatically activated they may be evaluated for use in linear accelerator rooms without interlocks.

22. Where separate 'machine/modulator' rooms are used, 60 minutes fire compartment arrangements are appropriate. Fire suppression gas systems are particularly suitable for rooms of this type in protecting equipment and giving early suppression of fire.

Fire notices

23. Printed instructions as to the action to be taken in the event of a fire should be displayed adjacent to each fire alarm call point.

24. Fire safety signs must comply with the relevant requirements of the Health and Safety (Safety Signs and Signals) Regulations 1996.

Operational implications

25. An emphasis on safety in connection with high-tension electricity is clearly appropriate. Fire teams should be made aware that linear accelerators contain high-storage value electrical capacitors, which take some considerable time to discharge following the isolation of the linear accelerator from its power supply.

26. In operational terms and when considering fire emergency/contingency plans, it is important that there be careful liaison with those responsible for radiation protection. Clearly any precaution that is taken to protect against radiation should also be appropriate in the fire context and vice versa. In addition to the local RPA already mentioned, consultation with the radiation protection supervisor who will be a senior professional member of the radiotherapy or oncology staff is also of value. The fire rules should be appended to or contained within the radiation protection local rules for the reasons already mentioned.

Glossary of terms and abbreviations

A&E	Accident and emergency
BMT	Bone marrow transplant
CCTV	Closed circuit television
CT	Computed tomography
DDA	Disability Discrimination Act
DR	Digital radiography
EPR	Electronic patient record
F-18	Radioactive substance – Fluorine-18
FD30	30 minutes fire resisting door
FDG	2 - (Fluorine-18) Fluoro-2 - Deoxy-0-Glucose
GP	General practitioner
HBN	NHS Estates, England Health Building Note
HDR	High Dose rate brachytherapy
HIS	Hospital information system
HSC	Health & Safety Commission
HTM	NHS Estates, England Health Technical Memorandum
ICRP	International Commission for Radiation Protection
IRR	Ionising Radiations Regulations
IT	Information technology
LAN	Local area network (computer communications)
LA	Linear accelerator treatment machine
LDR	Low dose rate brachytherapy
Linac	Linear accelerator

LMP	Low melting point
LPA	Laser radiation protection advisor (MDA guidance)
MDA	Medical Devices Agency
MDR	Medium dose rate brachytherapy
MLC	Multi-leaf collimator for LA
MRI	Magnetic resonance imaging
NICE	National Institute for Clinical Excellence
NOF	New Opportunities Fund
NSCLC	Example of modern chemotherapy techniques
PDR	Pulse dose rate brachytherapy
PET	Positron emission tomography
PFI	Private Finance Initiative
QA	Quality assurance
Rf	Radio-frequency radiation or transmissions
RPA	Radiation protection advisor (1999 IRR)
RPS	Radiation protection supervisor (1999 IRR)
RTP	Radiotherapy treatment planning
SHPN	Scottish Health Planning Note
SHTM	Scottish Health Technical Memoranda
Shr/WC	Shower/toilet
T	Tesla magnetic field strength
TBI	Total body irradiation usually by LA
TLD	Thermo luminescent dosimetry
UVEX	Polycarbonate material used in immobilisation of patients
VRM	Verification record and management of treatment data
WAN	Wide area network

NHSScotland guidance

Listed below is NHSScotland guidance some of which relates to this SHPN. The guidance produced by the Property and Environment Forum Executive is correct at the time of publication of this SHPN. Refer to the Forum website, www.show.scot.nhs/pef for the full current list of guidance.

General publications

Access Audit Checklist: Access for Disabled People in Healthcare Premises, Property and Environment Forum Executive, 2000

Scottish Health Facilities Note 14 – 'Disability access', Property and Environment Forum Executive, 2000

Scottish Capital Investment Manual, The Stationery Office

Overview:
Project Organisation
Business Case Guide
Management of Construction Projects
Commissioning a Healthcare Facility
Information Management and Technology Guide
Post-Project Evaluation

Cancer in Scotland: Action for Change, Scottish Executive Website, 2001

Our National Health: A Plan for Action, A Plan for Change, The Stationery Office

Scottish Health Facilities Note 30 'Infection Control in the Built Environment: Design and Planning', Property and Environment Forum Executive.

Scottish Health Planning Notes

03 General design guidance, 2001

04 In-patient accommodation: Options for choice, 2000

06 Facilities for Diagnostic Imaging and Interventional Radiology, 2001

08 Facilities for rehabilitation services, 2001

20 Facilities for Mortuary and Post-Mortem Room Services, 2001

27 **Intensive Care Unit**, 2000

28 **Facilities for Cardiac Services**, 2001

35 **Accommodation for people with mental illness Part 1 – The acute unit**, 2000

35 **Accommodation for people with mental illness Part 2 – Treatment and care in the community**, 2000

52 **Accommodation for day care Part 1 – Day surgery unit**, 2001

52 **Accommodation for day care Part 2 – Endoscopy unit**, 2001

52 **Accommodation for day care Part 3 – Medical investigation and treatment unit**, 2001

Scottish Hospital Planning Notes

1 **Health Service building in Scotland**, TSO 1991

2 **Hospital briefing and operational policy**, TSO 1993

12 **Out-patients department (with DBS)**,TSO 1993

12 **Out-patients department Supplement A – Activity space data sheets**,TSO 1993

12 **Out-patients department Supplement 1 – Gernilo-urinary medicine clinics**, TSO 1993;

12 **Out-patients department Supplement 2– Oral surgery, orthodontics, restorative dentistry**,TSO 1996

13 **Sterile services department**, TSO 1994

15 **Accommodation for pathology services**, TSO 1994

21 **Maternity department**, TSO 1994

22 **Accident and emergency department in an acute general hospital**, TSO 1995

22 **Accident and emergency department in an acute general hospital Supplement 1 – Trauma care and minor injury**, TSO 1995

26 **Operating department**, TSO 1992

26 **Operating department Supplement 1 – Activity space data sheets**, TSO

34 **Estate maintenance and works operations**, TSO 1992

34 **Estate maintenance and works operations Supplement 1 – Activity space data sheets**, TSO 1993

40 **Common activity spaces Volume 5 – Scottish appendix**, TSO 1996 (Joint HBN/SHPN – NHS Estates)

45 **External works for health buildings**, TSO 1994

47 **Health records department**, TSO 1995

51 **Accommodation at the main entrance of a District General Hospital**, TSO 1992

51 **Accommodation at the main entrance of a District General Hospital Supplement A – Activity space data sheets**, TSO 1993

51 **Accommodation at the main entrance of a District General Hospital Supplement 1 – Miscellaneous spaces in a District General Hospital**, TSO 1992

51 **Accommodation at the main entrance of a District General Hospital Supplement 1A- Miscellaneous spaces in a District General Hospital – Activity space data sheets**, TSO 1993

NHSScotland Firecode SHTMs

81 **Fire Precautions in New Hospitals**, 1999

82 **Alarm and Detection Systems**, 1999

83 **Fire Safety in Healthcare Premises**, 1999

Scottish Health Technical Memoranda

SHTM 2005 Building management systems

Part 1	Overview and management responsibilities
Part 2	Design considerations
Part 3	Validation and verification
Part 4	Operational management

SHTM 2007 Electrical services supply and distribution

Part 1	Overview and management responsibilities
Part 2	Design considerations
Part 3	Validation and verification

Part 4 Operational management

SHTM 2009 Pneumatic air tube transport systems

Part 1 Overview and management responsibilities

Part 2 Design considerations and Good Practice guide

SHTM 2010 Sterilization

Part 1 Overview and management responsibilities

Part 2 Design considerations

Part 3 Validation and verification

Part 4 Operational management

Part 5 Good practice guide

Part 6 Testing and validation protocols

SHTM 2011 Emergency electrical services

Part 1 Overview and management responsibilities

Part 2 Design considerations

Part 3 Validation and verification

Part 4 Operational management

SHTM 2015 Bedhead services

Part 1 Overview and management responsibilities

Part 2 Design considerations

Part 3 Validation and verification/Operational management

SHTM 2020 Electrical safety code for low voltage systems (Escode – LV)

Volume 1 Operational management

SHTM 2021 Electrical safety code for high voltage systems (Escode – HV)

Part 1 Overview and management responsibilities

Part 2 Operational management

SHTM 2022 Medical gas pipeline systems

Part 1 Design, installation, validation and verification

Part 2 Operational management

Supplement 1 Dental compressed air and vacuum systems

Supplement 2 Piped medical gases in ambulance services

SHTM 2023 Access and accommodation for engineering services

Part 1 Overview and management responsibilities

Part 2 Good practice guide

SHTM 2024 Lifts

Part 1 Overview and management responsibilities
Part 2 Design considerations
Part 3 Validation and verification
Part 4 Operational management

SHTM 2025 Ventilation in healthcare premises

Part 1 Overview and management responsibilities
Part 2 Design considerations
Part 3 Validation and verification
Part 4 Operational management

SHTM 2027 Hot and cold water supply, storage and mains services

Part 1 Overview and management responsibilities
Part 2 Design considerations
Part 3 Operational management
Part 4 Validation and verification

SHTM 2030 Washer-disinfectors

Part 1 Design considerations
Part 2 Operational management
Part 3 Validation and verification

SHTM 2031 Clean steam for sterilization

SHTM 2035 Mains signalling

Part 1 Overview and management responsibilities
Part 2 Design considerations
Part 3 Validation and verification/Operational management

SHTM 2040 The control of legionellae in healthcare premises – a code of practice

Part 1 Overview and management responsibilities
Part 2 Design considerations
Part 3 Operational management
Part 4 Validation and verification
Part 5 Good practice guide

Part 6	Supplementary guidance applicable to intermittently used healthcare premises

SHTM 2045 Acoustics

Part 1	Overview and management responsibilities
Part 2	Design considerations
Part 3	Validation and verification/Operational management
Part 4	Audiology

SHGN **The Pressure Systems and Transportable Gas Containers Regulations 1989**

SHGN **'Safe' hot water and surface temperatures**

SHGN **Static discharges**

SHTN 2 **Domestic hot and cold water systems for Scottish Healthcare Premises**

SHTN 3 **Management and disposal of clinical waste**

SHTN 4 **General Purposes Estates and Facilities Model Safety Permit-to-Work System**

Other References

Acts and Regulations

Consumer Protection Act 1987, The Stationery Office, 1987

Disability Discrimination Act 1995, The Stationery Office, 1995 (http://www.legislation.hmso.gov.uk/acts/acts1995/Ukpga_19950050_en_1.htm)

Health and Safety at Work Act, 1974, The Stationery Office, 1974

Radioactive Substances Act 1993, The Stationery Office, 1993 (http://www.legislation.hmso.gov.uk/acts/acts1993/Ukpga_19930012_en_1.htm)

The Building Standards (Scotland) Amendment Regulations 2001, The Stationery Office, 2001

Technical Standards – For compliance with the Building Standards (Scotland) Regulations 1990, as amended, The Stationery Office, 2002

SI 1994: 3140 The Construction (Design and Management) Regulations, The Stationery Office, 1994 (http://www.legislation.hmso.gov.uk/si/si1994/Uksi_19943140_en_1.htm)

SI 1999: 437 The Control of Substances Hazardous to Health Regulations (COSHH), The Stationery Office, 1999 (http://www.hmso.gov.uk/si/si1999/19990437.htm)

SI 1992: 2372 The Electromagnetic Compatibility Regulations, The Stationery Office, 1992 (http://www.hmso.gov.uk/si/si1992/Uksi_19922372_en_1.htm#tcon)

SI 1996: 341 The Health and Safety (Safety Signs and Signals) Regulations, The Stationery Office, 1996 (http://www.legislation.hmso.gov.uk/si/si1996/Uksi_19960341_en_1.htm)

SI 1992: 2792 Health and Safety (Display Screen Equipment) Regulations, The Stationery Office, 1992 (http://www.legislation.hmso.gov.uk/si/si1992/Uksi_19922792_en_1.htm)

SI 1999: 3232 The Ionising Radiations Regulations, The Stationery Office, 1999 (http://www.legislation.hmso.gov.uk/si/si1999/19993232.htm)

SI 2000: 1059 The Ionising Radiation (Medical Exposure) Regulations, The Stationery Office, 2000 (http://www.legislation.hmso.gov.uk/si/si2000/20001059.htm)

SI 1999: 3242 The Management of Health and Safety at Work Regulations, The Stationery Office, 1999
(http://www.legislation.hmso.gov.uk/si/si1999/19993242.htm)

SI 1998: 2306 The Provision and Use of Work Equipment Regulations, The Stationery Office, 1998
(http://www.hmso.gov.uk/si/si1998/19982306.htm)

SI 1992: The Workplace (Health, Safety and Welfare) Regulations, The Stationery Office, 1992
(http://www.hmso.gov.uk/si/si1992/Uksi_19923004_en_1.htm#tcon)

Council Directive 89/336/EEC of 3 May 1989 on the approximation of the laws of the Member States relating to electromagnetic compatibility, Official Journal L 139, 23/05/1989 p. 0019 - 0026
(http://europa.eu.int/eur-lex/en/lif/dat/1989/en_389L0336.html)
Amended by 392L0031 (OJ L 126 12.05.1992 p.11) Amended by 393L0068 (OJ L 220 30.08.1993 p.1) Incorporated by 294A0103(52) (OJ L 001 03.01.1994 p.263)

Council Directive 90/270/EEC of 29 May 1990 on the minimum safety and health requirements for work with display screen equipment. Official Journal L 156, 21/06/1990 p. 0014 - 0018. The Stationery Office, 1992
(http://europa.eu.int/eur-lex/en/lif/dat/1990/en_390L0270.html)

Department of Health (England)

Guidance on the application of the minimum ergonomic working standards for personnel engaged in the preparation, scanning and reporting of cervical screening slides (Addendum to MDA/97/31) Sep-97 MDA/97/31S NCSP. Medical Devices Agency, 1997.

NHS Estates, England

The design of hospital main entrances (Design Guide), NHS Estates, the Stationery Office, 1993

Magnetic resonance imaging (Health Guidance Note), NHS Estates, the Stationery Office, 1997

Health Building Notes (HBNs) (England)

HBN 6 **Facilities for diagnostic imaging and interventional radiology**, NHS Estates, The Stationery Office, 2001

HBN 20 **Facilities for mortuary and post-mortem room services**, NHS Estates, 2001

HBN 23 **Hospital accommodation of children and young people**, NHS Estates, The Stationery Office, 1994

HBN 26 **Operating department**, NHS Estates, The Stationery Office, 1991

HBN 29 **Accommodation for pharmaceutical services**, NHS Estates, The Stationery Office, 1997

HBN 36 **Local healthcare facilities**, NHS Estates, The Stationery Office, 1995 (new edition in preparation)

HBN 40 **Common activity spaces**

Vol 1: Public areas. NHS Estates, The Stationery Office, 1995

Vol 2: Treatment areas. NHS Estates, The Stationery Office, 1995

Vol 3: Staff areas. NHS Estates, The Stationery Office, 1995

Vol 4: Circulation areas. NHS Estates, The Stationery Office, 1995

Vol 5: Scottish Appendix, The Station

HBN 45 **External works for health buildings**, NHS Estates, The Stationery Office, 1992

HBN 48 **Telephone services**, NHS Estates, The Stationery Office, 1997

Health Technical Memoranda (HTMs) (England)

HTM 63 **Fitted storage systems**, NHS Estates, The Stationery Office, 1989

HTM 67 **Laboratory fitting out systems**, NHS Estates, The Stationery Office, 1993

HTM 2014 **Abatement of electrical interference**

Management policy NHS Estates, The Stationery Office, 1993.

Design considerations NHS Estates, The Stationery Office, 1993.

Validation and verification NHS Estates, The Stationery Office, 1993.

Operational management NHS Estates, The Stationery Office, 1993.

British Standards

BS 2881:1989 Specification for cupboards for the storage of medicines in healthcare premises, British Standards Institute, 1989, (Confirmed 1994)

BS 4533 Luminaires, British Standards Institution. (produced in various sections)

BS 5266: 1999 Emergency lighting, Code of practice for the emergency lighting of premises other than cinemas and certain other specified premises used for entertainment, British Standards Institute, 1999

BS 5839: 1988 Fire detection and alarm systems for buildings. Code of practice for system design, installation and servicing, British Standards Institution, 1988, (under review)

BS 6651:1999 Code of practice for protection of structures against lightning, British Standards Institute, 1999

BS EN 779:1993 Particulate air filters for general ventilation. Requirements, testing, marking (with amendments), British Standards Institution, 1993 (under review)

BS EN 12056-2:2000 Gravity drainage systems inside buildings. Sanitary pipework, layout and calculation, British Standards Institution, 2000

BS EN 55015:2001 Limits and methods of measurement of radio disturbance characteristics of electrical lighting and similar equipment, British Standards Institution, 2001. (1996 edition remains current)

BS EN 60601-1-2: 1993 Medical electrical equipment. General requirements for safety. Collateral standard. Electromagnetic compatibility. Requirements and tests, British Standards Institution, 1993

Others

Air distribution systems (Commissioning code A), The Chartered Institution of Building Services Engineers (CIBSE), 1996

The Disability Discrimination Act: access to goods, facilities and services (DL 80), Department of Social Security, 1996

Guidance on the structure and function of cancer centres, Board of Faculty of Clinical Oncology, Royal College of Radiologists, 1996

Guidance to engineering commissioning, Institute of Healthcare Engineering and Estate Management, 1995

Lighting guide: Hospital and health care buildings (LG2), Chartered Institution of Building Services Engineers (CIBSE), 1989 (under review)

Occupational exposure limits (EH40), Health and Safety Executive, HSE Books, issued annually

Plowman, Rosalind, et al. **The socio-economic burden of hospital-acquired infection**, Public Health Laboratory Service, 1999 (issued in three volumes)

Public health engineering (CIBSE Guide G), The Chartered Institution of Building Services Engineers (CIBSE), 1999

The visual environment for display screen use (LG3), The Chartered Institution of Building Services Engineers (CIBSE), 1996

Water distribution systems (Commissioning code W), The Chartered Institution of Building Services Engineers (CIBSE), 1994

Work with ionising radiation: Ionising Radiations Regulations 1999: approved code of practice and guidance, Health and Safety Commission, HSE Books, 2000 and through good booksellers

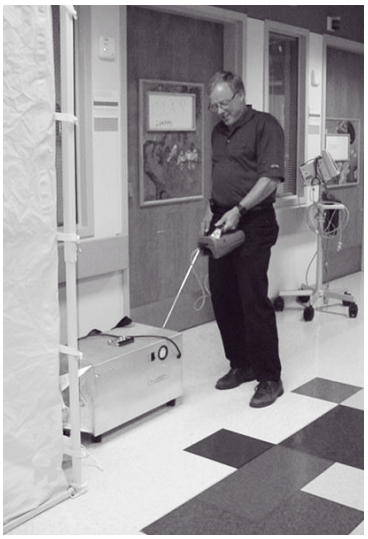
MMWR™

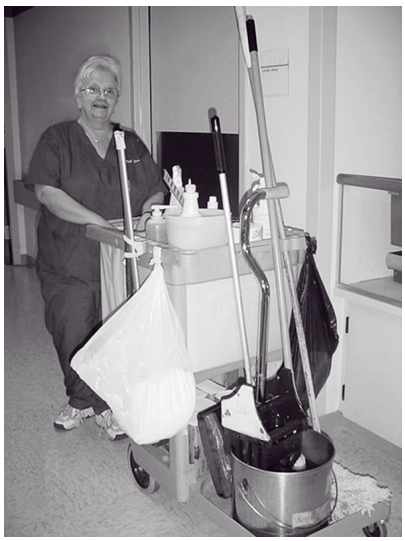
Morbidity and Mortality Weekly Report

Recommendations and Reports June 6, 2003 / Vol. 52 / No. RR-10

Guidelines for Environmental Infection Control in Health-Care Facilities

Recommendations of CDC and the Healthcare Infection Control Practices Advisory Committee (HICPAC)





DEPARTMENT OF HEALTH AND HUMAN SERVICES
CENTERS FOR DISEASE CONTROL AND PREVENTION

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On the Cover: Left, airborne-particle sampling is used to evaluate construction barriers; right, the efforts of housekeeping staff are key to environmental infection control in health-care facilities. Photos used with permission.

CONTENTS

Disclosure of Relationship

Raymond Y.W. Chinn is a private-practice physician and salaried employee of Sharp Memorial Hospital in San Diego, California. Dr. Chinn received no research funds from commercial sources either directly, or indirectly through awards made to the hospital, before or during the development of this guideline.

Guidelines for Environmental Infection Control in Health-Care Facilities

Recommendations of CDC and the Healthcare Infection Control Practices Advisory Committee (HICPAC)

Prepared by
Lynne Sehulster, Ph.D.[1]
Raymond Y.W. Chinn, M.D.[2]
[1]*Division of Healthcare Quality Promotion*
National Center for Infectious Diseases
[2]*HICPAC member*
Sharp Memorial Hospital
San Diego, California

Summary

The health-care facility environment is rarely implicated in disease transmission, except among patients who are immunocompromised. Nonetheless, inadvertent exposures to environmental pathogens (e.g., Aspergillus *spp. and* Legionella *spp.) or airborne pathogens (e.g.,* Mycobacterium tuberculosis *and varicella-zoster virus) can result in adverse patient outcomes and cause illness among health-care workers. Environmental infection-control strategies and engineering controls can effectively prevent these infections. The incidence of health-care–associated infections and pseudo-outbreaks can be minimized by 1) appropriate use of cleaners and disinfectants; 2) appropriate maintenance of medical equipment (e.g., automated endoscope reprocessors or hydrotherapy equipment); 3) adherence to water-quality standards for hemodialysis, and to ventilation standards for specialized care environments (e.g., airborne infection isolation rooms, protective environments, or operating rooms); and 4) prompt management of water intrusion into the facility. Routine environmental sampling is not usually advised, except for water quality determinations in hemodialysis settings and other situations where sampling is directed by epidemiologic principles, and results can be applied directly to infection-control decisions.*

This report reviews previous guidelines and strategies for preventing environment-associated infections in health-care facilities and offers recommendations. These include 1) evidence-based recommendations supported by studies; 2) requirements of federal agencies (e.g., Food and Drug Administration, U.S. Environmental Protection Agency, U.S. Department of Labor, Occupational Safety and Health Administration, and U.S. Department of Justice); 3) guidelines and standards from building and equipment professional organizations (e.g., American Institute of Architects, Association for the Advancement of Medical Instrumentation, and American Society of Heating, Refrigeration, and Air-Conditioning Engineers); 4) recommendations derived from scientific theory or rationale; and 5) experienced opinions based upon infection-control and engineering practices. The report also suggests a series of performance measurements as a means to evaluate infection-control efforts.

Introduction

Parameters of the Report

This report, which contains the complete list of recommendations with pertinent references, is Part II of *Guidelines for Environmental Infection Control in Health-Care Facilities.* The full four-part guidelines will be available on CDC's Division of Healthcare Quality Promotion (DHQP) website. Relative to previous CDC guidelines, this report

- revises multiple sections (e.g., cleaning and disinfection of environmental surfaces, environmental sampling, laundry and bedding, and regulated medical waste) from previous editions of CDC's *Guideline for Handwashing and Hospital Environmental Control*;
- incorporates discussions of air and water environmental concerns from CDC's *Guideline for Prevention of Nosocomial Pneumonia*;
- consolidates relevant environmental infection-control measures from other CDC guidelines; and
- includes two topics not addressed in previous CDC guidelines — infection-control concerns related to animals in health-care facilities and water quality in hemodialysis settings.

The material in this report originated in the National Center for Infectious Diseases, James M. Hughes, M.D., Director; and the Division of Healthcare Quality Promotion, Steven L. Solomon, M.D., Acting Director.

In the full guidelines, Part I, Background Information: Environmental Infection Control in Health-Care Facilities, provides a comprehensive review of the relevant scientific literature. Attention is given to engineering and infection-control concerns during construction, demolition, renovation, and repair of health-care facilities. Use of an infection-control risk assessment is strongly supported before the start of these or any other activities expected to generate dust or water aerosols. Also reviewed in Part I are infection-control measures used to recover from catastrophic events (e.g., flooding, sewage spills, loss of electricity and ventilation, or disruption of water supply) and the limited effects of environmental surfaces, laundry, plants, animals, medical wastes, cloth furnishings, and carpeting on disease transmission in health-care facilities. Part III and Part IV of the full guidelines provide references (for the complete guideline) and appendices, respectively.

Part II (this report) contains recommendations for environmental infection control in health-care facilities, describing control measures for preventing infections associated with air, water, or other elements of the environment. These recommendations represent the views of different divisions within CDC's National Center for Infectious Diseases and the Healthcare Infection Control Practices Advisory Committee (HICPAC), a 12-member group that advises CDC on concerns related to the surveillance, prevention, and control of health-care–associated infections, primarily in U.S. health-care facilities. In 1999, HICPAC's infection-control focus was expanded from acute-care hospitals to all venues where health care is provided (e.g., outpatient surgical centers, urgent care centers, clinics, outpatient dialysis centers, physicians' offices, and skilled nursing facilities). The topics addressed in this report are applicable to the majority of health-care facilities in the United States. This report is intended for use primarily by infection-control practitioners, epidemiologists, employee health and safety personnel, engineers, facility managers, information systems professionals, administrators, environmental service professionals, and architects. Key recommendations include

- infection-control impact of ventilation system and water system performance;
- establishment of a multidisciplinary team to conduct infection-control risk assessment;
- use of dust-control procedures and barriers during construction, repair, renovation, or demolition;
- environmental infection-control measures for special areas with patients at high risk;
- use of airborne-particle sampling to monitor the effectiveness of air filtration and dust-control measures;
- procedures to prevent airborne contamination in operating rooms when infectious tuberculosis (TB) patients require surgery;
- guidance regarding appropriate indications for routine culturing of water as part of a comprehensive control program for legionellae;
- guidance for recovering from water-system disruptions, water leaks, and natural disasters (e.g., flooding);
- infection-control concepts for equipment using water from main lines (e.g., water systems for hemodialysis, ice machines, hydrotherapy equipment, dental unit water lines, and automated endoscope reprocessors);
- environmental surface cleaning and disinfection strategies with respect to antibiotic-resistant microorganisms;
- infection-control procedures for health-care laundry;
- use of animals in health care for activities and therapy;
- managing the presence of service animals in health-care facilities;
- infection-control strategies for when animals receive treatment in human health-care facilities; and
- a call to reinstate the practice of inactivating amplified cultures and stocks of microorganisms onsite during medical waste treatment.

Topics outside the scope of this report include 1) noninfectious adverse events (e.g., sick building syndrome), 2) environmental concerns in the home, 3) home health care, 4) terrorism, and 5) health-care–associated foodborne illness.

Wherever possible, the recommendations in this report are based on data from well-designed scientific studies. However, certain of these studies were conducted by using narrowly defined patient populations or specific health-care settings (e.g., hospitals versus long-term care facilities), making generalization of findings potentially problematic. Construction standards for hospitals or other health-care facilities may not apply to residential home-care units. Similarly, infection-control measures indicated for immunosuppressed patient care are usually not necessary in those facilities where such patients are not present.

Other recommendations were derived from knowledge gained during infectious disease investigations in health-care facilities, where successful termination of the outbreak was often the result of multiple interventions, the majority of which cannot be independently and rigorously evaluated. This is especially true for construction situations involving air or water.

Other recommendations were derived from empiric engineering concepts and may reflect industry standards rather than evidence-based conclusions. Where recommendations refer to guidance from the American Institute of Architects

(AIA), the statements reflect standards intended for new construction or renovation. Existing structures and engineered systems are expected to be in continued compliance with those standards in effect at the time of construction or renovation.

Also, in the absence of scientific confirmation, certain infection-control recommendations that cannot be rigorously evaluated are based on strong theoretic rationale and suggestive evidence. Finally, certain recommendations are derived from existing federal regulations.

Performance Measurements

Infections caused by the microorganisms described in this guideline are rare events, and the effect of these recommendations on infection rates in a facility may not be readily measurable. Therefore, the following steps to measure performance are suggested to evaluate these recommendations:

1. Document whether infection-control personnel are actively involved in all phases of a health-care facility's demolition, construction, and renovation. Activities should include performing a risk assessment of the necessary types of construction barriers, and daily monitoring and documenting of the presence of negative airflow within the construction zone or renovation area.
2. Monitor and document daily the negative airflow in AII rooms and positive airflow in PE rooms, especially when patients are in these rooms.
3. Perform assays at least once a month by using standard quantitative methods for endotoxin in water used to reprocess hemodialyzers, and for heterotrophic and mesophilic bacteria in water used to prepare dialysate and for hemodialyzer reprocessing.
4. Evaluate possible environmental sources (e.g., water, laboratory solutions, or reagents) of specimen contamination when nontuberculous mycobacteria (NTM) of unlikely clinical importance are isolated from clinical cultures. If environmental contamination is found, eliminate the probable mechanisms.
5. Document policies to identify and respond to water damage. Such policies should result in either repair and drying of wet structural or porous materials within 72 hours, or removal of the wet material if drying is unlikely within 72 hours.

Updates to Previous Recommendations

Contributors to this report reviewed primarily English-language manuscripts identified from reference searches using the National Library of Medicine's MEDLINE, bibliographies of published articles, and infection-control textbooks. All the recommendations may not reflect the opinions of all reviewers. This report updates the following published guidelines and recommendations:

CDC. Guideline for handwashing and hospital environmental control. MMWR 1998;37(No. 24). Replaces sections on microbiologic sampling, laundry, infective waste, and housekeeping.

Tablan OC, Anderson LJ, Arden NH, et al., Hospital Infection Control Practices Advisory Committee. Guideline for prevention of nosocomial pneumonia. Infect Control Hosp Epidemiol 1994;15:587–627. Updates and expands environmental infection-control information for aspergillosis and Legionnaires disease; online version incorporates Appendices B, C, and D addressing environmental control and detection of Legionella spp.

CDC. Guidelines for preventing the transmission of *mycobacterium tuberculosis* in health-care facilities. MMWR 1994;43(No. RR13). Provides supplemental information on engineering controls.

CDC. Recommendations for preventing the spread of vancomycin resistance: recommendations of the Hospital Infection Control Practices Advisory Committee (HICPAC). MMWR 1995;44(No. RR12). Supplements environmental infection-control information from the section, Hospitals with Endemic VRE or Continued VRE Transmission.

Garner JS, Hospital Infection Control Practices Advisory Committee. Guideline for isolation precautions in hospitals. Infect Control Hosp Epidemiol 1996;17:53–80. Supplements and updates topics in Part II — Recommendations for Isolation Precautions in Hospitals (linen and laundry, routine and terminal cleaning, airborne precautions).

Mangram AJ, Horan TC, Pearson ML, Silver LC, Jarvis WR, Hospital Infection Control Practices Advisory Committee. Guideline for prevention of surgical site infection. Infect Control Hosp Epidemiol 1999;4:250–78. Updates operating room ventilation and surface cleaning/disinfection recommendations from the section, Intraoperative Issues: Operating Room Environment.

U.S. Public Health Service, Infectious Diseases Society of America, Prevention of Opportunistic Infections Working Group. USPHS/IDSA guidelines for the prevention of opportunistic infections in persons infected with human immunodeficiency virus. Infect Dis Obstet Gynecol 2002; 10:3–64. Supplements information regarding patient interaction with pets and animals in the home.

CDC, Infectious Diseases Society of America, American Society of Blood and Marrow Transplantation. Guidelines for preventing opportunistic infections among hematopoietic stem cell transplant recipients. Cytotherapy 2001;3:41–54. Supplements and updates the section, Hospital Infection Control.

Key Terms

Airborne infection isolation (AII) refers to the isolation of patients infected with organisms spread via airborne droplet nuclei <5 µm in diameter. This isolation area receives numerous air changes per hour (ACH) (≥12 ACH for new construction as of 2001; ≥6 ACH for construction before 2001), and is under negative pressure, such that the direction of the air flow is from the outside adjacent space (e.g., the corridor) into the room. The air in an AII room is preferably exhausted to the outside, but may be recirculated provided that the return air is filtered through a high-efficiency particulate air (HEPA) filter. The use of personal respiratory protection is also indicated for persons entering these rooms when caring for TB or smallpox patients and for staff who lack immunity to airborne viral diseases (e.g., measles or varicella zoster virus [VZV] infection).

Protective environment (PE) is a specialized patient-care area, usually in a hospital, with a positive air flow relative to the corridor (i.e., air flows from the room to the outside adjacent space). The combination of HEPA filtration, high numbers of air changes per hour (≥12 ACH), and minimal leakage of air into the room creates an environment that can safely accommodate patients who have undergone allogeneic hematopoietic stem cell transplant (HSCT).

Immunocompromised patients are those patients whose immune mechanisms are deficient because of immunologic disorders (e.g., human immunodeficiency virus [HIV] infection or congenital immune deficiency syndrome), chronic diseases (e.g., diabetes, cancer, emphysema, or cardiac failure), or immunosuppressive therapy (e.g., radiation, cytotoxic chemotherapy, anti-rejection medication, or steroids). Immunocompromised patients who are identified as high-risk patients have the greatest risk of infection caused by airborne or waterborne microorganisms. Patients in this subset include persons who are severely neutropenic for prolonged periods of time (i.e., an absolute neutrophil count [ANC] of ≤500 cells/mL), allogeneic HSCT patients, and those who have received the most intensive chemotherapy (e.g., childhood acute myelogenous leukemia patients).

Abbreviations

AAMI	Association for the Advancement of Medical Instrumentation
ACH	air changes per hour
AER	automated endoscope reprocessor
AHJ	authority having jurisdiction
AIA	American Institute of Architects
AII	airborne infection isolation
ANSI	American National Standards Institute
ASHRAE	American Society of Heating, Refrigeration, and Air-Conditioning Engineers
BMBL	Biosafety in Microbiological and Biomedical Laboratories (CDC/National Institutes of Health)
CFR	Code of Federal Regulations
CJD	Creutzfeldt-Jakob disease
CPL	compliance document (OSHA)
DFA	direct fluorescence assay
DHHS	U.S. Department of Health and Human Services
DOT	U.S. Department of Transportation
EC	environment of care
EPA	U. S. Environmental Protection Agency
FDA	U.S. Food and Drug Administration
HBV	hepatitis B virus
HEPA	high efficiency particulate air
HIV	human immunodeficiency virus
HSCT	hematopoietic stem cell transplant
HVAC	heating, ventilation, air conditioning
ICRA	infection-control risk assessment
JCAHO	Joint Commission on Accreditation of Healthcare Organizations
NaOH	sodium hydroxide
NTM	nontuberculous mycobacteria
OSHA	Occupational Safety and Health Administration
PE	protective environment
PPE	personal protective equipment
TB	tuberculosis
USC	United States Code
USDA	U.S. Department of Agriculture
UV	ultraviolet
UVGI	ultraviolet germicidal irradiation
VHF	viral hemorrhagic fever
VRE	vancomycin-resistant *Enterococcus*
VRSA	vancomycin-resistant *Staphylococcus aureus*
VZV	varicella zoster virus

Recommendations for Environmental Infection Control in Health-Care Facilities

Rationale for Recommendations

As in previous CDC guidelines, each recommendation is categorized on the basis of existing scientific data, theoretic rationale, applicability, and possible economic effect. The recommendations are evidence-based wherever possible. However, certain recommendations are derived from empiric infection-control or engineering principles, theoretic rationale, or from experience gained from events that cannot be readily studied (e.g., floods).

The HICPAC system for categorizing recommendations has been modified to include a category for engineering standards and actions required by state or federal regulations. Guidelines and standards published by the AIA, American Society of Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE), and the Association for the Advancement of Medical Instrumentation (AAMI) form the basis of certain recommendations. These standards reflect a consensus of expert opinions and extensive consultation with agencies of the U.S. Department of Health and Human Services. Compliance with these standards is usually voluntary. However, state and federal governments often adopt these standards as regulations. For example, the standards from AIA regarding construction and design of new or renovated health-care facilities, have been adopted by reference by >40 states. Certain recommendations have two category ratings (e.g., Categories IA and IC or Categories IB and IC), indicating the recommendation is evidence-based as well as a standard or regulation.

Rating Categories

Recommendations are rated according to the following categories:

Category IA. Strongly recommended for implementation and strongly supported by well-designed experimental, clinical, or epidemiologic studies.

Category IB. Strongly recommended for implementation and supported by certain experimental, clinical, or epidemiologic studies and a strong theoretic rationale.

Category IC. Required by state or federal regulation, or representing an established association standard. (Note: Abbreviations for governing agencies and regulatory citations are listed where appropriate. Recommendations from regulations adopted at state levels are also noted. Recommendations from AIA guidelines cite the appropriate sections of the standards.)

Category II. Suggested for implementation and supported by suggestive clinical or epidemiologic studies, or a theoretic rationale.

Unresolved issue. No recommendation is offered. No consensus or insufficient evidence exists regarding efficacy.

Recommendations — Air

I. Air-Handling Systems in Health-Care Facilities

A. Use AIA guidelines as minimum standards where state or local regulations are not in place for design and construction of ventilation systems in new or renovated health-care facilities. Ensure that existing structures continue to meet the specifications in effect at the time of construction (*1*). Category IC (AIA: 1.1.A, 5.4)

B. Monitor ventilation systems in accordance with engineers' and manufacturers' recommendations to ensure preventive engineering, optimal performance for removal of particulates, and elimination of excess moisture (*1–8*). Category IB, IC (AIA: 7.2, 7.31.D, 8.31.D, 9.31.D, 10.31.D, 11.31.D, Environmental Protection Agency [EPA] guidance)

1. Ensure that heating, ventilation, air conditioning (HVAC) filters are properly installed and maintained to prevent air leakages and dust overloads (*2,4,6,9*). Category IB
2. Monitor areas with special ventilation requirements (e.g., AII or PE) for ACH, filtration, and pressure differentials (*1,7,8,10–26*). Category IB, IC (AIA: 7.2.C7, 7.2.D6)
   a. Develop and implement a maintenance schedule for ACH, pressure differentials, and filtration efficiencies by using facility-specific data as part of the multidisciplinary risk assessment. Take into account the age and reliability of the system.
   b. Document these parameters, especially the pressure differentials.
3. Engineer humidity controls into the HVAC system and monitor the controls to ensure adequate moisture removal (*1*). Category IC (AIA: 7.31.D9)
   a. Locate duct humidifiers upstream from the final filters.

b. Incorporate a water-removal mechanism into the system.
c. Locate all duct takeoffs sufficiently downstream from the humidifier so that moisture is completely absorbed.

4. Incorporate steam humidifiers, if possible, to reduce potential for microbial proliferation within the system, and avoid use of cool-mist humidifiers. Category II
5. Ensure that air intakes and exhaust outlets are located properly in construction of new facilities and renovation of existing facilities (*1,27*). Category IC (AIA: 7.31.D3, 8.31.D3, 9.31.D3, 10.31.D3, 11.31.D3)
   a. Locate exhaust outlets >25 ft from air-intake systems.
   b. Locate outdoor air intakes ≥6 ft above ground or ≥3 ft above roof level.
   c. Locate exhaust outlets from contaminated areas above roof level to minimize recirculation of exhausted air.
6. Maintain air intakes and inspect filters periodically to ensure proper operation (*1,11–16,27*). Category IC (AIA: 7.31.D8)
7. Bag dust-filled filters immediately upon removal to prevent dispersion of dust and fungal spores during transport within the facility (*4,28*). Category IB
   a. Seal or close the bag containing the discarded filter.
   b. Discard spent filters as regular solid waste, regardless of the area from which they were removed (*28*).
8. Remove bird roosts and nests near air intakes to prevent mites and fungal spores from entering the ventilation system (*27,29,30*). Category IB
9. Prevent dust accumulation by cleaning air-duct grilles in accordance with facility-specific procedures and schedules and when rooms are not occupied by patients (*1,10–16*). Category IC, II (AIA: 7.31.D10)
10. Periodically measure output to monitor system function; clean ventilation ducts as part of routine HVAC maintenance to ensure optimum performance (*1,31,32*). Category IC, II (AIA: 7.31.D10)

C. Use portable, industrial-grade HEPA filter units capable of filtration rates in the range of 300–800 ft^3/min to augment removal of respirable particles as needed (*33*). Category II
   1. Select portable HEPA filters that can recirculate all or nearly all of the room air and provide the equivalent of ≥12 ACH (*34*). Category II
   2. Portable HEPA filter units placed in construction zones can be used later in patient-care areas, provided all internal and external surfaces are cleaned, and the filter replaced or its performance verified by appropriate particle testing. Category II
   3. Situate portable HEPA units with the advice of facility engineers to ensure that all room air is filtered (*34*). Category II
   4. Ensure that fresh-air requirements for the area are met (*33,35*). Category II

D. Follow appropriate procedures for use of areas with through-the-wall ventilation units (*1*). Category IC (AIA: 8.31.D1, 8.31.D8, 9.31.D23, 10.31.D18, 11.31.D15)
   1. Do not use such areas as PE rooms (*1*). Category IC (AIA: 7.2.D3)
   2. Do not use a room with a through-the-wall ventilation unit as an AII room unless it can be demonstrated that all required AII engineering controls are met (*1,34*). Category IC (AIA: 7.2.C3)

E. Conduct an infection-control risk assessment (ICRA) and provide an adequate number of AII and PE rooms (if required) or other areas to meet the needs of the patient population (*1,2,7,8,17,19, 20,34,36–43*). Category IA, IC (AIA: 7.2.C, 7.2.D)

F. When ultraviolet germicidal irradiation (UVGI) is used as a supplemental engineering control, install fixtures 1) on the wall near the ceiling or suspended from the ceiling as an upper air unit; 2) in the air-return duct of an AII area; or 3) in designated enclosed areas or booths for sputum induction (*34*). Category II

G. Seal windows in buildings with centralized HVAC systems, including PE areas (*1,3,44*). Category IB, IC (AIA: 7.2.D3)

H. Keep emergency doors and exits from PE rooms closed except during an emergency; equip emergency doors and exits with alarms. Category II

I. Develop a contingency plan for backup capacity in the event of a general power failure (*45*). Category IC (Joint Commission on Accreditation of Healthcare Organizations [JCAHO]: Environment of Care [EC] 1.4)
   1. Emphasize restoration of appropriate air quality and ventilation conditions in AII rooms, PE

rooms, operating rooms, emergency departments, and intensive care units (*1,45*). Category IC (AIA: 1.5.A1; JCAHO: EC 1.4)

2. Deploy infection-control procedures to protect occupants until power and systems functions are restored (*1,36,45*). Category IC (AIA: 5.1, 5.2; JCAHO: EC 1.4)

J. Do not shut down HVAC systems in patient-care areas exept for maintenance, repair, testing of emergency backup capacity, or new construction (*1,46*). Category IB, IC (AIA: 5.1, 5.2.B, C)
   1. Coordinate HVAC system maintenance with infection-control staff and relocate immunocompromised patients if necessary (*1*). Category IC (AIA: 5.1, 5.2)
   2. Provide backup emergency power and air-handling and pressurization systems to maintain filtration, constant ACH, and pressure differentials in PE rooms, AII rooms, operating rooms, and other critical-care areas (*1,37,47*). Category IC (AIA: 5.1, 5.2)
   3. For areas not served by installed emergency ventilation and backup systems, use portable units and monitor ventilation parameters and patients in those areas (*33*). Category II
   4. Coordinate system startups with infection-control staff to protect patients in PE rooms from bursts of fungal spores (*1,3,37,47*). Category IC (AIA: 5.1, 5.2)
   5. Allow sufficient time for ACH to clean the air once the system is operational (Table 1) (*1,33*). Category IC (AIA: 5.1, 5.2)

K. HVAC systems serving offices and administrative areas may be shut down for energy conservation purposes, but the shutdown must not alter or adversely affect pressure differentials maintained in laboratories or critical-care areas with specific ventilation requirements (i.e., PE rooms, AII rooms, operating rooms). Category II

L. Whenever possible, avoid inactivating or shutting down the entire HVAC system, especially in acute-care facilities. Category II

M. Whenever feasible, design and install fixed backup ventilation systems for new or renovated construction of PE rooms, AII rooms, operating rooms, and other critical-care areas identified by ICRA (*1*). Category IC (AIA: 1.5.A1)

TABLE 1. Air changes/hour (ACH) and time required for airborne-contaminant removal efficiencies of 99% and 99.9%

ACH	Time (min) required for removal efficiency of 99%	Time (min) required for removal efficiency of 99.9%
2*†	138	207
4	69	104
6	**46**	**69**
8	35	52
10	28	41
12	23	35
15	**18**	**28**
20	14	21
50	6	8

Sources: CDC. Guidelines for preventing the transmission of *Mycobacterium tuberculosis* in health-care facilities. MMWR 1994;43(No. RR-13).

American Conference of Governmental Industrial Hygienists. HVAC components, functions and malfunctions (Topic 8-4). In: Industrial ventilation: a manual of recommended practice. 24th ed. Cincinnati, OH: American Conference of Governmental Industrial Hygienists, 2001.

Mutchler JE. Principles of ventilation. In: NIOSH. The industrial environment — its evaluation and control. Washington, DC: US Department of Health, Education, and Welfare, Public Health Service, 1973. DHHS publication no. (NIOSH) 74-117. Available at: http://www.cdc.gov/niosh/74-117.html.

Note: Bold entries denote frequently cited ACH for patient-care areas.

*Values were derived from the formula

$t_2 - t_1 = -[\ln (C_2 / C_1) / (Q / V)] \times 60$, with $t_1 = 0$

where

t_1 = initial timepoint (min)
t_2 = final timepoint (min)
C_1 = initial concentration of contaminant
C_2 = final concentration of contaminant
$C_2 / C_1 = 1 -$ (removal efficiency/100)
Q = air flow rate in cubic feet/hour
V = room volume in cubic feet
Q / V = ACH

† Values apply to an empty room with no aerosol-generating source. With a person present and generating aerosol, this table would not apply. Other equations are available that include a constant generating source. However, certain diseases (e.g., infectious tuberculosis) are not likely to be aerosolized at a constant rate. The times given assume perfect mixing of the air within the space (i.e., mixing factor = 1). However, perfect mixing usually does not occur. Removal times will be longer in rooms or areas with imperfect mixing or air stagnation. Caution should be exercised in using this table in such situations. For booths or other local ventilation enclosures, manufacturers' instructions should be consulted.

II. Construction, Renovation, Remediation, Repair, and Demolition

A. Establish a multidisciplinary team that includes infection-control staff to coordinate demolition, construction, and renovation projects and consider proactive preventive measures at the inception; produce and maintain summary statements of the team's activities (*1,9,11–16,38,48–51*). Category IB, IC (AIA: 5.1)

B. Educate both the construction team and health-care staff in immunocompromised patient-care areas regarding the airborne infection risks associated with construction projects, dispersal of fungal spores during such activities, and methods to control the dissemination of fungal spores (*11–16,27,50,52–56*). Category IB

C. Incorporate mandatory adherence agreements for infection control into construction contracts, with penalties for noncompliance and mechanisms to ensure timely correction of problems (*1,11,13–16,27,50*). Category IC (AIA: 5.1)

D. Establish and maintain surveillance for airborne environmental disease (e.g., aspergillosis) as appropriate during construction, renovation, repair, and demolition activities to ensure the health and safety of immunocompromised patients (*27,57–59*). Category IB
   1. Using active surveillance, monitor for airborne infections in immunocompromised patients (*27,37,57,58*). Category IB
   2. Periodically review the facility's microbiologic, histopathologic, and postmortem data to identify additional cases (*27,37,57,58*). Category IB
   3. If cases of aspergillosis or other health-care–associated airborne fungal infections occur, aggressively pursue the diagnosis with tissue biopsies and cultures as feasible (*11,13–16,27,50,57–59*). Category IB

E. Implement infection-control measures relevant to construction, renovation, maintenance, demolition, and repair (*1,16,49,50,60*). Category IB, IC (AIA: 5.1, 5.2)
   1. Before the project gets under way, perform an ICRA to define the scope of the activity and the need for barrier measures (*1,11,13–16,48–51,60*). Category IB, IC (AIA: 5.1)
      a. Determine if immunocompromised patients may be at risk for exposure to fungal spores from dust generated during the project (*13–16,48,51*).
      b. Develop a contingency plan to prevent such exposures (*13–16,48,51*).
   2. Implement infection-control measures for external demolition and construction activities (*11,13–16,50,61,62*). Category IB
      a. Determine if the facility can operate temporarily on recirculated air; if feasible, seal off adjacent air intakes.
      b. If this is not possible or practical, check the low-efficiency (roughing) filter banks frequently and replace as needed to avoid buildup of particulates.
      c. Seal windows and reduce wherever possible other sources of outside air intrusion (e.g., open doors in stairwells and corridors), especially in PE areas.
   3. Avoid damaging the underground water system (i.e., buried pipes) to prevent soil and dust contamination of the water (*1,63*). Category IB, IC (AIA: 5.1)
   4. Implement infection-control measures for internal construction activities (*1,11,13–16,48–50,64*). Category IB, IC (AIA: 5.1, 5.2)
      a. Construct barriers to prevent dust from construction areas from entering patient-care areas; ensure that barriers are impermeable to fungal spores and in compliance with local fire codes (*1,45,48,49,55,64–66*).
      b. Seal off and block return air vents if rigid barriers are used for containment (*1,16,50*).
      c. Implement dust-control measures on surfaces and divert pedestrian traffic away from work zones (*1,48,49,64*).
      d. Relocate patients whose rooms are adjacent to work zones, depending on their immune status, the scope of the project, the potential for generation of dust or water aerosols, and the methods used to control these aerosols (*1,64,65*).
   5. Perform those engineering and work-site related infection-control measures as needed for internal construction, repairs, and renovations (*1,48,49,51,64,66*). Category IB, IC (AIA: 5.1, 5.2)
      a. Ensure proper operation of the air-handling system in the affected area after erection of barriers and before the room or area is set to negative pressure (*39,47,50,64*). Category IB
      b. Create and maintain negative air pressure in work zones adjacent to patient-care areas and ensure that required engineering controls are maintained (*1,48,49,51,64,66*).
      c. Monitor negative airflow inside rigid barriers (*1,67*).
      d. Monitor barriers and ensure integrity of the construction barriers; repair gaps or breaks in barrier joints (*1,65,66,68*).

e. Seal windows in work zones if practical; use window chutes for disposal of large pieces of debris as needed, but ensure that the negative pressure differential for the area is maintained (*1,13,48*).
f. Direct pedestrian traffic from construction zones away from patient-care areas to minimize dispersion of dust (*1,13–16,44,48–51,64*).
g. Provide construction crews with 1) designated entrances, corridors, and elevators wherever practical; 2) essential services (e.g., toilet facilities) and convenience services (e.g., vending machines); 3) protective clothing (e.g., coveralls, footgear, and headgear) for travel to patient-care areas; and 4) a space or anteroom for changing clothing and storing equipment (*1,11,13–16,50*).
h. Clean work zones and their entrances daily by 1) wet-wiping tools and tool carts before their removal from the work zone; 2) placing mats with tacky surfaces inside the entrance; and 3) covering debris and securing this covering before removing debris from the work zone (*1,11,13–16,50*).
i. In patient-care areas, for major repairs that include removal of ceiling tiles and disruption of the space above the false ceiling, use plastic sheets or prefabricated plastic units to contain dust; use a negative pressure system within this enclosure to remove dust; and either pass air through an industrial-grade, portable HEPA filter capable of filtration rates of 300–800 ft^3/min., or exhaust air directly to the outside (*16,50,64,67,69*).
j. Upon completion of the project, clean the work zone according to facility procedures, and install barrier curtains to contain dust and debris before removing rigid barriers (*1,11,13–16,48–50*).
k. Flush the water system to clear sediment from pipes to minimize waterborne microorganism proliferation (*1,63*).
l. Restore appropriate ACH, humidity, and pressure differential; clean or replace air filters; dispose of spent filters (*3,4,28,47*).

F. Use airborne-particle sampling as a tool to evaluate barrier integrity (*3,70*). Category II
G. Commission the HVAC system for newly constructed health-care facilities and renovated spaces before occupancy and use, with emphasis on ensuring proper ventilation for operating rooms, AII rooms, and PE areas (*1,70–72*). Category IC (AIA: 5.1; ASHRAE: 1-1996)
H. No recommendation is offered regarding routine microbiologic air sampling before, during, or after construction, or before or during occupancy of areas housing immunocompromised patients (*9,48,49,51,64,73,74*). Unresolved issue
I. If a case of health-care–acquired aspergillosis or other opportunistic environmental airborne fungal disease occurs during or immediately after construction, implement appropriate follow-up measures (*40,48,75–78*). Category IB
    1. Review pressure-differential monitoring documentation to verify that pressure differentials in the construction zone and in PE rooms are appropriate for their settings (*1,40,78*). Category IB, IC (AIA: 5.1)
    2. Implement corrective engineering measures to restore proper pressure differentials as needed (*1,40,78*). Category IB, IC (AIA: 5.1)
    3. Conduct a prospective search for additional cases and intensify retrospective epidemiologic review of the hospital's medical and laboratory records (*27,48,76,79,80*). Category IB
    4. If no epidemiologic evidence of ongoing transmission exists, continue routine maintenance in the area to prevent health-care–acquired fungal disease (*27,75*). Category IB
J. If no epidemiologic evidence exists of ongoing transmission of fungal disease, conduct an environmental assessment to find and eliminate the source (*11,13–16,27,44,49–51,60,81*). Category IB
    1. Collect environmental samples from potential sources of airborne fungal spores, preferably by using a high-volume air sampler rather than settle plates (*2,4,11,13–16,27,44,49,50,64,65,81–86*). Category IB
    2. If either an environmental source of airborne fungi or an engineering problem with filtration or pressure differentials is identified, promptly perform corrective measures to eliminate the source and route of entry (*49,60*). Category IB
    3. Use an EPA-registered antifungal biocide (e.g., copper-8-quinolinolate) for decontaminating structural materials (*16,61,66,87*). Category IB
    4. If an environmental source of airborne fungi is not identified, review infection-control mea-

sures, including engineering controls, to identify potential areas for correction or improvement (*88,89*). Category IB

5. If possible, perform molecular subtyping of *Aspergillus* spp. isolated from patients and the environment to compare their strain identities (*90–94*). Category II

K. If air-supply systems to high-risk areas (e.g., PE rooms) are not optimal, use portable, industrial-grade HEPA filters on a temporary basis until rooms with optimal air-handling systems become available (*1,13–16,27,50*). Category II

III. Infection Control and Ventilation Requirements for PE rooms

A. Minimize exposures of severely immunocompromised patients (e.g., solid-organ transplant patients or allogeneic neutropenic patients) to activities that might cause aerosolization of fungal spores (e.g., vacuuming or disruption of ceiling tiles) (*37,48,51,73*). Category IB

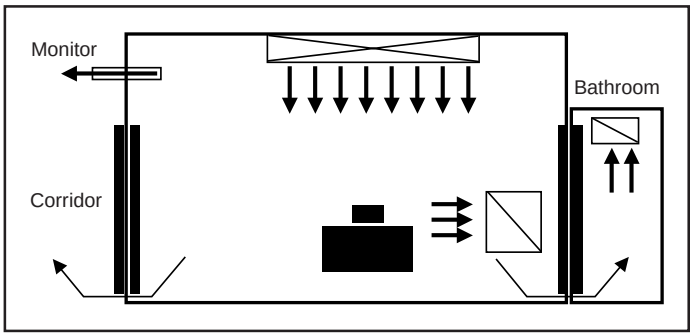
B. Minimize the length of time that immunocompromised patients in PE are outside their rooms for diagnostic procedures and other activities (*37,62*). Category IB

C. Provide respiratory protection for severely immunocompromised patients when they must leave PE for diagnostic procedures and other activities; consult the most recent revision of CDC's *Guideline for Prevention of Health-Care–Associated Pneumonia* for information regarding the appropriate type of respiratory protection. (*27,37*). Category II

D. Incorporate ventilation engineering specifications and dust-controlling processes into the planning and construction of new PE units (Figure 1). Category IB, IC

1. Install central or point-of-use HEPA filters for supply (incoming) air (*1,2,27,48,56,70, 80,82,85,95–102*). Category IB, IC (AIA: 5.1, 5.2, 7.2.D)
2. Ensure that rooms are well-sealed by 1) properly constructing windows, doors, and intake and exhaust ports; 2) maintaining ceilings that are smooth and free of fissures, open joints, and crevices; 3) sealing walls above and below the ceiling; and 4) monitoring for leakage and making any necessary repairs (*1,27,44,100,101*). Category IB, IC (AIA: 7.2.D3)

FIGURE 1. Example of positive-pressure room control for protection from airborne environmental microbes*†



Source: Adapted from Heating/Piping/Air Conditioning (HPAC) Engineering, October 2000, Penton Media, Inc.

Note: Stacked black boxes represent patient's bed. Long open box with cross-hatch represents supply air. Open boxes with single, diagonal slashes represent air exhaust registers. Arrows indicate directions of airflow.

*Possible uses include immunocompromised patient rooms (e.g., hematopoietic stem cell transplant or solid organ transplant procedure rooms) and orthopedic operating rooms.

† Positive-pressure room engineering features include

- positive pressure (greater supply than exhaust air volume);
- pressure differential range of 2.5–8 Pa (0.01–0.03-in. water gauge), ideal at 8 Pa;
- airflow differential >125-cfm supply versus exhaust;
- sealed room, approximately 0.5-sq. ft. leakage;
- clean to dirty airflow;
- monitoring;
- ≥12 air changes/hr (ACH); and
- return air if refiltered.

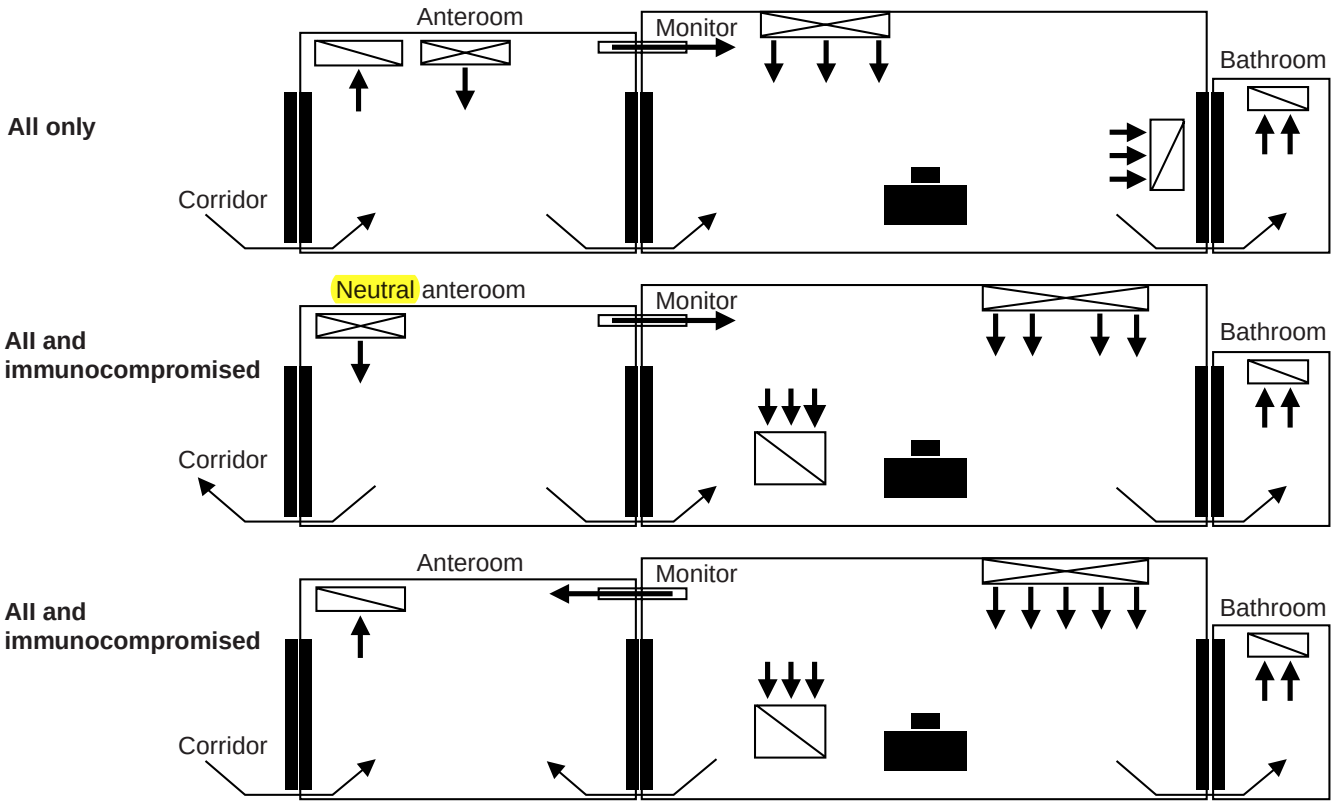
3. Ventilate the room to maintain ≥12 ACH (*1,27,37,100,101,103*). Category IC (AIA: 7.2.D)
4. Locate air supply and exhaust grilles so that clean, filtered air enters from one side of the room, flows across the patient's bed, and exits from the opposite side of the room (*1,27,100,101*). Category IC (AIA: 7.31.D1)
5. Maintain positive room air pressure (≥2.5 Pa [0.01-inch water gauge]) in relation to the corridor (*1,3,27,100,101*). Category IB, IC (AIA: Table 7.2)
6. Maintain airflow patterns and monitor these on a daily basis by using permanently installed visual means of detecting airflow in new or renovated construction, or by using other visual methods (e.g., flutter strips or smoke tubes) in existing PE units. Document the monitoring results (*1,13*). Category IC (AIA: 7.2.D6)
7. Install self-closing devices on all room exit doors in PE rooms (*1*). Category IC (AIA: 7.2.D4)

E. Do not use laminar air flow systems in newly constructed PE rooms (*99,101*). Category II

F. Take measures to protect immunocompromised patients who would benefit from a PE room and who also have an airborne infectious disease (e.g., acute VZV infection or tuberculosis).
   1. Ensure that the patient's room is designed to maintain positive pressure.
   2. Use an anteroom to ensure appropriate air-balance relationships and provide independent exhaust of contaminated air to the outside, or place a HEPA filter in the exhaust duct if the return air must be recirculated (*1,100*) (Figure 2). Category IC (AIA: 7.2.D1, A7.2.D)
   3. If an anteroom is not available, place the patient in AII and use portable, industrial-grade HEPA filters to enhance filtration of spores in the room (*33*). Category II

G. Maintain backup ventilation equipment (e.g., portable units for fans or filters) for emergency provision of required ventilation for PE areas and take immediate steps to restore the fixed ventilation system (*1,37,47*). Category IC (AIA: 5.1)

FIGURE 2. Example of airborne infection isolation (AII) room with anteroom and neutral anteroom*



Source: Used with permission from Andrew J. Streifel, M.P.H., University of Minnesota.
Note: Top diagram indicates airflow patterns when patient with only airborne infectious disease occupies room. Middle and bottom diagrams indicate recommended airflow patterns when room is occupied by immunocompromised patient with airborne infectious disease. Stacked black boxes represent patient beds. Long open boxes with cross-hatches represent supply air. Open boxes with single, diagonal slashes represent air exhaust registers. Arrows indicate directions of airflow.
*AII isolation room with anteroom engineering features include
- pressure differential of 2.5 Pa (0.01-in. water gauge);
- airflow differential >125 cfm supply versus exhaust;
- sealed room with approximately 0.5-sq. ft. leakage;
- clean to dirty airflow;
- monitoring;
- ≥12 air exchanges/hr (ACH) new or renovation, 6 ACH existing; and
- anteroom airflow patterns

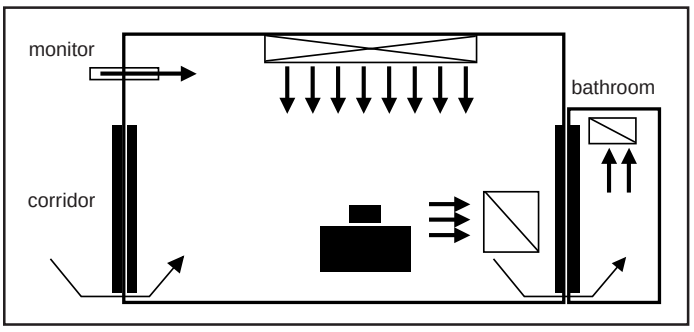
IV. Infection-Control and Ventilation Requirements for AII Rooms

A. Incorporate certain specifications into the planning and construction or renovation of AII units (*1,34,100,101,104*) (Figure 3). Category IB, IC
   1. Maintain continuous negative air pressure (2.5 Pa [0.01 inch water gauge]) in relation to the air pressure in the corridor; monitor air pressure periodically, preferably daily, with audible manometers or smoke tubes at the door (for existing AII rooms), or with a permanently installed visual monitoring mechanism. Document the results of monitoring (*1,100,101*). Category IC (AIA: 7.2.C7, Table 7.2)
   2. Ensure that rooms are well-sealed by properly constructing windows, doors, and air-intake and exhaust ports; when monitoring indicates air leakage, locate the leak and make necessary repairs (*1,99,100*). Category IB, IC (AIA: 7.2.C3)
   3. Install self-closing devices on all AII room exit doors (*1*). Category IC (AIA: 7.2.C4)
   4. Provide ventilation to ensure ≥12 ACH for renovated rooms and new rooms, and ≥6 ACH for existing AII rooms (*1,34,104*). Category IB, IC (AIA: Table 7.2)
   5. Direct exhaust air to the outside, away from air-intake and populated areas. If this is not practical, air from the room can be recirculated after passing through a HEPA filter (*1,34*). Category IC (AIA: Table 7.2)

B. Where supplemental engineering controls for air cleaning are indicated from a risk assessment of the AII area, install UVGI units in the exhaust air ducts of the HVAC system to supplement HEPA filtration or install UVGI fixtures on or near the ceiling to irradiate upper room air (*34*). Category II

C. Implement environmental infection-control measures for persons with diagnosed or suspected airborne infectious diseases.
   1. Use AII rooms for patients with or suspected of having an airborne infection who also require cough-inducing procedures, or use an enclosed booth that is engineered to provide 1) ≥12 ACH; 2) air supply and exhaust rate sufficient to maintain a 2.5 Pa (0.01-inch water gauge) negative pressure difference with respect to all surrounding spaces with an exhaust rate of ≥50 ft^3/min; and 3) air exhausted directly outside away from air intakes and traffic or exhausted after HEPA filtration before recirculation (*1,34,105–107*). Category IB, IC (AIA: 7.15.E, 7.31.D23, 9.10, Table 7.2)
   2. Although airborne spread of viral hemorrhagic fever (VHF) has not been documented in a health-care setting, prudence dictates placing a VHF patient in an AII room, preferably with an anteroom, to reduce the risk of occupational exposure to aerosolized infectious material in blood, vomitus, liquid stool, and respiratory secretions present in large amounts during the end stage of a patient's illness (*108–110*). Category II
      a. If an anteroom is not available, use portable, industrial-grade HEPA filters in the patient's room to provide additional ACH equivalents for removing airborne particulates.
      b. Ensure that health-care workers wear face shields or goggles with appropriate respirators when entering the rooms of VHF patients with prominent cough, vomiting, diarrhea, or hemorrhage (*109*).

FIGURE 3. Example of negative-pressure room control for airborne infection isolation (AII)*†



Source: Adpted from Heating/Piping/Air Conditioning (HPAC) Engineering, October 2000, Penton Media, Inc.
Note: Stacked black boxes represent patient's bed. Long open box with cross-hatch represents supply air. Open boxes with single, diagonal slashes represent air exhaust registers. Arrows indicate direction of airflow.
*Possible uses include treatment or procedure rooms, bronchoscopy rooms, and autopsy.
†Negative-pressure room engineering features include
- negative pressure (greater exhaust than supply air volume);
- pressure differential of 2.5 Pa (0.01-in. water gauge);
- airflow differential >125-cfm supply versus exhaust;
- sealed room, approximately 0.5-sq. ft. leakage;
- clean to dirty airflow;
- monitoring;
- ≥12 air exchanges/hr (ACH) new or renovation, 6 ACH existing; and
- exhaust to outside or HEPA-filtered if recirculated.

3. Place smallpox patients in negative pressure rooms at the onset of their illness, preferably using a room with an anteroom, if available (*36*). Category II

D. No recommendation is offered regarding negative pressure or isolation for patients with *Pneumocystis carinii* pneumonia (*111–113*). Unresolved issue.

E. Maintain backup ventilation equipment (e.g., portable units for fans or filters) for emergency provision of ventilation requirements for AII rooms, and take immediate steps to restore the fixed ventilation system (*1,34,47*). Category IC (AIA: 5.1)

V. Infection-Control and Ventilation Requirements for Operating Rooms

A. Implement environmental infection-control and ventilation measures for operating rooms.

1. Maintain positive-pressure ventilation with respect to corridors and adjacent areas (*1,114,115*). Category IB, IC (AIA: Table 7.2)
2. Maintain ≥15 ACH, of which ≥3 ACH should be fresh air (*1,116,117*). Category IC (AIA: Table 7.2)
3. Filter all recirculated and fresh air through the appropriate filters, providing 90% efficiency (dust-spot testing) at a minimum (*1,118*). Category IC (AIA: Table 7.3)
4. In rooms not engineered for horizontal laminar airflow, introduce air at the ceiling and exhaust air near the floor (*1,115,119*). Category IC (AIA: 7.31.D4)
5. Do not use ultraviolet (UV) lights to prevent surgical-site infections (*115,120–126*). Category IB
6. Keep operating room doors closed except for the passage of equipment, personnel, and patients, and limit entry to essential personnel (*127,128*). Category IB

B. Follow precautionary procedures for infectious TB patients who also require emergency surgery (*34,129,130*). Category IB, IC

1. Use an N95 respirator approved by the National Institute for Occupational Safety and Health without exhalation valves in the operating room (*129,131*). Category IC (Occupational Safety and Health Administration [OSHA]; 29 Code of Federal Regulations [CFR] 1910.134,139)

2. Intubate the patient in either the AII room or the operating room; if intubating the patient in the operating room, do not allow the doors to open until 99% of the airborne contaminants are removed (Table 1) (*34,117*). Category IB
3. When anesthetizing a patient with confirmed or suspected TB, place a bacterial filter between the anesthesia circuit and patient's airway to prevent contamination of anesthesia equipment or discharge of tubercle bacilli into the ambient air (*130,132*). Category IB
4. Extubate and allow the patient to recover in an AII room (*34,117*). Category IB
5. If the patient has to be extubated in the operating room, allow adequate time for ACH to clean 99% of airborne particles from the air (Table 1), because extubation is a cough-producing procedure (*34,117*). Category IB

C. Use portable, industrial-grade HEPA filters temporarily for supplemental air cleaning during intubation and extubation for TB patients who require surgery (*33,34,117*). Category II
1. Position the units appropriately so that all room air passes through the filter; obtain engineering consultation to determine the appropriate placements (*34*). Category II
2. Switch the portable unit off during the surgical procedure. Category II
3. Provide fresh air as per ventilation standards for operating rooms; portable units do not meet the requirements for the number of fresh ACH (*1,33,133*). Category II

D. If possible, schedule TB patients as the last surgical cases of the day to maximize the time available for removal of airborne contamination. Category II

E. No recommendation is offered for performing orthopedic implant operations in rooms supplied with laminar airflow (*118,120*). Unresolved issue

F. Maintain backup ventilation equipment (e.g., portable units for fans or filters) for emergency ventilation of operating rooms, and take immediate steps to restore the fixed ventilation system (*1,47,131,134*). Category IB, IC (AIA: 5.1)

VI. Other Potential Infectious Aerosol Hazards in Health-Care Facilities

A. In settings where surgical lasers are used, wear appropriate personal protective equipment (PPE), including N95 or N100 respirators, to minimize exposure to laser plumes (*129,135,136*). Category IC (OSHA; 29 CFR 1910.134,139)

B. Use central wall suction units with in-line filters to evacuate minimal laser plumes (*135–138*). Category II

C. Use a mechanical smoke evacuation system with a high-efficiency filter to manage the generation of large amounts of laser plume, when ablating tissue infected with human papilloma virus (HPV) or performing procedures on a patient with extrapulmonary TB (*34,136,137,139–141*). Category II

Recommendations — Water

I. Controlling the Spread of Waterborne Microorganisms

A. Practice hand hygiene to prevent the hand transfer of waterborne pathogens, and use barrier precautions (e.g., gloves) as defined by other guidelines (*36,142–146*). Category IA

B. Eliminate contaminated water or fluid environmental reservoirs (e.g., in equipment or solutions) wherever possible (*142,147*). Category IB

C. Clean and disinfect sinks and wash basins on a regular basis by using an EPA-registered product as set by facility policies. Category II

D. Evaluate for possible environmental sources (e.g., potable water) of specimen contamination when waterborne microorganisms (e.g., NTM) of unlikely clinical importance are isolated from clinical cultures (e.g., specimens collected aseptically from sterile sites or, if postprocedural, colonization after use of tap water in patient care) (*148–151*). Category IB

E. Avoid placing decorative fountains and fish tanks in patient-care areas; ensure disinfection and fountain maintenance if decorative fountains are used in public areas of the health-care facility (*152*). Category IB

II. Routine Prevention of Waterborne Microbial Contamination Within the Distribution System

A. Maintain hot water temperature at the return at the highest temperature allowable by state regulations or codes, preferably ≥124°F (≥51°C), and maintain cold water temperature at <68°F (<20°C) (*27,153*). Category IC (States; ASHRAE: 12:2000)

B. If the hot water temperature can be maintained at ≥124°F (≥51°C), explore engineering options (e.g., installing preset thermostatic valves in point-of-use

fixtures) to help minimize the risk of scalding (*153*). Category II

C. When state regulations or codes do not allow hot water temperatures above the range of 105°F–120°F (40.6°C–49°C) for hospitals or 95°F–110°F (35°C–43.3°C) for nursing care facilities or when buildings cannot be retrofitted for thermostatic mixing valves, follow either of these alternative preventive measures to minimize the growth of *Legionella* spp. in water systems. Category II
   1. Periodically increase the hot water temperature to ≥150°F (≥66°C) at the point of use (*153*). Category II
   2. Alternatively, chlorinate the water and then flush it through the system (*153–155*). Category II

D. Maintain constant recirculation in hot-water distribution systems serving patient-care areas (*1*). Category IC (AIA: 7.31.E.3)

III. Remediation Strategies for Distribution System Repair or Emergencies

A. Whenever possible, disconnect the ice machine before planned water disruptions. Category II

B. Prepare a contingency plan to estimate water demands for the entire facility in advance of significant water disruptions (i.e., those expected to result in extensive and heavy microbial or chemical contamination of the potable water), sewage intrusion, or flooding (*45,156*). Category IC (JCAHO: EC 1.4)

C. When a significant water disruption or an emergency occurs, adhere to any advisory to boil water issued by the municipal water utility (*157*). Category IB, IC (Municipal order)
   1. Alert patients, families, staff, and visitors not to consume water from drinking fountains, ice, or drinks made from municipal tap water, while the advisory is in effect, unless the water has been disinfected (e.g., by bringing to a rolling boil for ≥1 minute) (*157*). Category IB, IC (Municipal order)
   2. After the advisory is lifted, run faucets and drinking fountains at full flow for ≥5minutes, or use high-temperature water flushing or chlorination (*153,157*). Category IC, II (Municipal order; ASHRAE: 12:2000)

D. Maintain a high level of surveillance for waterborne disease among patients after a boil water advisory is lifted. Category II

E. Corrective decontamination of the hot water system might be necessary after a disruption in service or a cross-connection with sewer lines has occurred.
   1. Decontaminate the system when the fewest occupants are present in the building (e.g., nights or weekends) (*27,153*). Category IC (ASHRAE: 12:2000)
   2. If using high-temperature decontamination, raise the hot-water temperature to 160°F–170°F (71°C–77°C) and maintain that level while progressively flushing each outlet around the system for ≥5 minutes (*27,153*). Category IC (ASHRAE: 12:2000)
   3. If using chlorination, add enough chlorine, preferably overnight, to achieve a free chlorine residual of ≥2 mg/L (≥2 ppm) throughout the system (*153*). Category IC (ASHRAE: 12:2000)
      a. Flush each outlet until chlorine odor is detected.
      b. Maintain the elevated chlorine concentration in the system for ≥2 (but ≤24 hrs).
   4. Use a thorough flushing of the water system instead of chlorination if a highly chlorine-resistant microorganism (e.g., *Cryptosporidium* spp.) is suspected as the water contaminant. Category II

F. Flush and restart equipment and fixtures according to manufacturer's instructions. Category II

G. Change the pretreatment filter and disinfect the dialysis water system with an EPA-registered product to prevent colonization of the reverse osmosis membrane and downstream microbial contamination (*158*). Category II

H. Run water softeners through a regeneration cycle to restore their capacity and function. Category II

I. If the facility has a water-holding reservoir or water-storage tank, consult the facility engineer or local health department to determine whether this equipment needs to be drained, disinfected with an EPA-registered product, and refilled. Category II

J. Implement facility procedures to manage a sewage system failure or flooding (e.g., arranging with other health-care facilities for temporary transfer of patients or provision of services), and establish communications with the local municipal water utility and the local health department to ensure that advisories are received in a timely manner after release (*45,156*). Category IC (JCAHO: EC 1.4; Municipal order)

K. Implement infection-control measures during sewage intrusion, flooding, or other water-related emergencies.
   1. Relocate patients and clean or sterilize supplies from affected areas. Category II
   2. If hands are not visibly soiled or contaminated with proteinaceous material, include an alcohol-based hand rub in the hand hygiene process 1) before performing invasive procedures; 2) before and after each patient contact; and 3) whenever hand hygiene is indicated (*146*). Category II
   3. If hands are visibly soiled or contaminated with proteinaceous material, use soap and bottled water for handwashing (*146*). Category II
   4. If the potable water system is not affected by flooding or sewage contamination, process surgical instruments for sterilization according to standard procedures. Category II
   5. Contact the manufacturer of the automated endoscope reprocessor (AER) for specific instructions on the use of this equipment during a water advisory. Category II

L. Remediate the facility after sewage intrusion, flooding, or other water-related emergencies.
   1. Close off affected areas during cleanup procedures. Category II
   2. Ensure that the sewage system is fully functional before beginning remediation so contaminated solids and standing water can be removed. Category II
   3. If hard-surfaced equipment, floors, and walls remain in good repair, ensure that these are dry within 72 hours; clean with detergent according to standard cleaning procedures. Category II
   4. Clean wood furniture and materials (if still in good repair); allow them to dry thoroughly before restoring varnish or other surface coatings. Category II
   5. Contain dust and debris during remediation and repair as outlined in air recommendations (Air: IIG 4, 5). Category II

M. Regardless of the original source of water damage (e.g., flooding versus water leaks from point-of-use fixtures or roofs), remove wet, absorbent structural items (e.g., carpeting, wallboard, and wallpaper) and cloth furnishings if they cannot be easily and thoroughly cleaned and dried within 72 hours (e.g., moisture content ≤20% as determined by moisture meter readings); replace with new materials as soon as the underlying structure is declared by the facility engineer to be thoroughly dry (*2,47,159,160*). Category IB

IV. Additional Engineering Measures as Indicated by Epidemiologic Investigation for Controlling Waterborne, Health-Care–Associated Legionnaires Disease

A. When using a pulse or one-time decontamination method, superheat the water by flushing each outlet for ≥5 minutes with water at 160°F–170°F (71°C–77°C) or hyperchlorinate the system by flushing all outlets for ≥5 minutes with water containing ≥2 mg/L (≥2 ppm) free residual chlorine using a chlorine-based product registered by the EPA for water treatment (e.g., sodium hypochlorite [chlorine bleach]) (*153,155,161–164*). Category IB

B. After a pulse treatment, maintain both the heated water temperature at the return and the cold water temperature per the recommendation (Water: II A) wherever practical and permitted by state codes, or chlorinate heated water to achieve 1–2 mg/L (1–2 ppm) free residual chlorine at the tap by using a chlorine-based product registered by the EPA for water treatment (e.g., sodium hypochlorite [bleach]) (*153,165–169*). Category IC (States; ASHRAE: 12:2000)

C. Explore engineering or educational options (e.g., install preset thermostatic mixing valves in point-of-use fixtures or post warning signs at each outlet) to minimize the risk of scalding for patients, visitors, and staff. Category II

D. No recommendation is offered for treating water in the facility's distribution system with chlorine dioxide, heavy-metal ions (e.g., copper or silver), monochloramines, ozone, or UV light (*170–188*). Unresolved issue

V. General Infection-Control Strategies for Preventing Legionnaires Disease

A. Conduct an infection-control risk assessment of the facility to determine if patients at risk or severely immunocompromised patients are present (*27,189,190*). Category IB

B. Implement general strategies for detecting and preventing Legionnaires disease in facilities that do not provide care for severely immunocompromised patients (i.e., facilities that do not have HSCT or solid-organ transplant programs) (see Appendix) (*27,189,190*). Category IB
   1. Establish a surveillance process to detect health-care–associated Legionnaires disease

(*27,189,190*). Category IB

2. Inform health-care personnel (e.g., infection control, physicians, patient-care staff, engineering) regarding the potential for Legionnaires disease to occur and measures to prevent and control health-care–associated legionellosis (*166,191*). Category IB
3. Establish mechanisms to provide clinicians with laboratory tests (e.g., culture, urine antigen, direct fluorescence assay [DFA], and serology) for the diagnosis of Legionnaires disease (*27,189*). Category IB

C. Maintain a high index of suspicion for health-care–associated Legionnaires disease, and perform laboratory diagnostic tests for legionellosis on suspected cases, especially in patients at risk who do not require a PE for care (e.g., patients receiving systemic steroids; patients aged ≥65 years; or patients with chronic underlying disease (e.g., diabetes mellitus, congestive heart failure, or chronic obstructive lung disease) (*27,166,190,192–198*). Category IA

D. Periodically review the availability and clinicians' use of laboratory diagnostic tests for Legionnaires disease in the facility; if clinicians' use of the tests on patients with diagnosed or suspected pneumonia is limited, implement measures (e.g., an educational campaign) to enhance clinicians' use of the test(s) (*193*). Category IB

E. If one case of laboratory-confirmed, health-care–associated Legionnaires disease is identified, or if two or more cases of laboratory-suspected, health-care-associated Legionnaires disease occur during a 6-month period, certain activities should be initiated (*181,189,191,193,199,200*). Category IB
   1. Report the cases to state and local health departments where required. Category IC (States)
   2. If the facility does not treat severely immunocompromised patients, conduct an epidemiologic investigation, including retrospective review of microbiologic, serologic, and postmortem data to look for previously unidentified cases of health-care–associated Legionnaires disease, and begin intensive prospective surveillance for additional cases (*27,181,189,191,193,199,200*). Category IB
   3. If no evidence of continued health-care–associated transmission exists, continue intensive prospective surveillance for ≥2 months after the initiation of surveillance (*27,181, 189,191,193,199,200*). Category IB

F. If there is evidence of continued health-care–associated transmission (i.e., an outbreak), conduct an environmental assessment to determine the source of *Legionella* spp. (*199–207*). Category IB
   1. Collect water samples from potential aerosolized water sources (Box 1 and Box 2) (*208*). Category IB
   2. Save and subtype isolates of *Legionella* spp. obtained from patients and the environment (*163,199–207,209*). Category IB
   3. If a source is identified, promptly institute water system decontamination measures per recommendations (see Water IV) (*164,210*). Category IB

BOX 1. Potential sampling sites for *Legionella* spp. in health-care facilities

Potable water system
- incoming water main
- water softener
- holding tanks, cisterns
- water heater tanks (at the inflows and outflows)

Potable water outlets, especially those in or near patient rooms
- faucets or taps
- showers

Cooling tower, evaporative condenser
- makeup water (e.g., added to replace water lost because of evaporation, drift, leakage)
- basin (i.e., area under the tower for collection of cooled water)
- sump (i.e., section of basin from which cooled water returns to heat source)
- heat sources (e.g., chillers)

Humidifiers (e.g., nebulizers)
- bubblers for oxygen
- water used for respiratory therapy equipment

Other sources
- decorative fountains
- irrigation equipment
- fire sprinkler system (if recently used)
- whirlpools, spas

Source: Barbaree JM, Gorman GW, Martin WT, Fields BS, Morrill WE. Protocol for sampling environmental sites for legionellae. Appl Environ Microbiol 1987;53:1454–8.

BOX 2. Procedures for collecting and processing environmental specimens for *Legionella* spp

1. Collect water (1-liter samples, if possible) in sterile, screw-top bottles.
2. Collect culture swabs of internal surfaces of faucets, aerators, and shower heads in a sterile, screw-top container (e.g., 50 mL plastic centrifuge tube). Submerge each swab in 5–10 mL of sample water taken from the same device from which the sample was obtained.
3. Transport samples and process in a laboratory proficient at culturing water specimens for *Legionella* spp, as soon as possible after collection.*
4. Test samples for the presence of *Legionella* spp. by using semiselective culture media using procedures specific to the cultivation and detection of *Legionella* spp.†§

Sources: Barbaree JM, Gorman GW, Martin WT, Fields BS, Morrill WE. Protocol for sampling environmental sites for legionellae. Appl Environ Microbiol 1987;53:1454–8.
CDC. Procedures for the recovery of *Legionella* from the environment. Atlanta GA: US Department of Health and Human Services, Public Health Service, 1992:1–13.
Alary MA, Joly JR. Comparison of culture methods and an immunofluorescence assay for the detection of *Legionella pneumophila* in domestic hot water devices. Curr Microbiol 1992;24:19–25.
Vickers RM, Stout JE, Yu VL. Failure of a diagnostic monoclonal immunofluorescent reagent to detect *Legionella pneumophila* in environmental samples. Appl Environ Microbiol 1990;56:2912–4.
Flournoy DJ, Belobraydic KA, Silberg SL, Lawrence CH, Guthrie PJ. False positive *Legionella pneumophila* direct immunofluorescence monoclonal antibody test caused by *Bacillus cereus* spores. Diag Microbiol Infect Dis 1988;9:123–5.
Bej AK, Majbubani MH, Atlas RM. Detection of viable *Legionella pneumophila* in water by polymerase chain reaction and gene probe methods. Appl Environ Microbiol 1991;57:597–600.

* Samples may be transported at room temperature but must be protected from temperature extremes. Samples not processed within 24 hours of collection should be refrigerated.
† Detection of *Legionella* spp. antigen by the direct fluorescent antibody technique is not suitable for environmental samples.
§ Use of polymerase chain reaction for identification of *Legionella* spp. is not recommended until more data regarding the sensitivity and specificity of this procedure are available.

4. If *Legionella* spp. are detected in ≥1 culture (e.g., conducted at 2-week intervals during 3 months), reassess the control measures, modify them accordingly, and repeat the decontamination procedures; consider intensive use of techniques used in the initial decontamination, or a combination of superheating and hyperchlorination (*27,210,211*). Category IB

G. If an environmental source is not identified during a Legionnaires disease outbreak, continue surveillance for new cases for ≥2 months. Either defer decontamination pending identification of the source of *Legionella* spp. or proceed with decontamination of the hospital's water distribution system, with special attention to areas involved in the outbreak. Category II

H. No recommendation is offered regarding routine culturing of water systems in health-care facilities that do not have patient-care areas (i.e., PE or transplant units) for persons at high risk for *Legionella* spp. infection (see Appendix) (*161,165,167, 198,212–214*). Unresolved issue

I. No recommendation is offered regarding the removal of faucet aerators in areas for immunocompetent patients. Unresolved issue

J. Keep adequate records of all infection-control measures and environmental test results for potable water systems. Category II

VI. Preventing Legionnaires Disease in Protective Environments and Transplant Units

A. When implementing strategies for preventing Legionnaires disease among severely immunocompromised patients housed in facilities with HSCT or solid-organ transplant programs, incorporate these specific surveillance and epidemiologic measures in addition to the steps outlined previously (see Appendix).
   1. Maintain a high index of suspicion for legionellosis in transplant patients even when environmental surveillance cultures do not yield legionellae (*189,215*). Category IB
   2. If a case occurs in a severely immunocompromised patient, or if severely immunocompromised patients are present in high-risk areas of the hospital (e.g., PE or transplant units) and cases are identified elsewhere in the facility, conduct a combined epidemiologic and environmental investigation to determine the source of *Legionella* spp. (*189,210*). Category IB

B. Implement culture strategies and potable water and fixture treatment measures in addition to those previous outlined (Water: V). Category II
   1. Depending on state regulations on potable water temperature in public buildings (*216*), hospitals housing patients at high risk for health-care–associated legionellosis should either maintain heated water with a minimum return temperature of ≥124°F (≥51°C) and cold water at <68°F (<20°C), or chlorinate heated water to achieve 1–2 mg/L (1–2 ppm) of free residual chlorine at the tap (*153–155,165,167–169,217*). Category II

2. Periodic culturing for legionellae in potable water samples from HSCT or solid-organ transplant units can be performed as part of a comprehensive strategy to prevent Legionnaires disease in these units (*37,154,189,218*). Category II
3. No recommendation is offered regarding the optimal methodology (i.e., frequency or number of sites) for environmental surveillance cultures in HSCT or solid-organ transplant units. Unresolved issue
4. In areas with patients at risk, when *Legionella* spp. are not detectable in unit water, remove, clean, and disinfect shower heads and tap aerators monthly by using a chlorine-based, EPA-registered product. If an EPA-registered chlorine disinfectant is not available, use a chlorine bleach solution (500–615 ppm [1:100 v/v dilution]) (*153,187*). Category II

C. If *Legionella* spp. are determined to be present in the water of a transplant unit, implement certain measures until *Legionella* spp. are no longer detected by culture.
1. Decontaminate the water supply as outlined previously (Water: IV) (*27,37,153,164,210*). Category IB
2. Do not use water from the faucets in patient-care rooms to avoid creating infectious aerosols (*37,219*). Category IB
3. Restrict severely immunocompromised patients from taking showers (*37,219*). Category IB
4. Use water that is not contaminated with *Legionella* spp. for HSCT patients' sponge baths (*37,219*). Category IB
5. Provide patients with sterile water for tooth brushing, drinking, and for flushing nasogastric tubing during legionellosis outbreaks (*37,219*). Category IB

D. Do not use large-volume room air humidifiers that create aerosols (e.g., by Venturi principle, ultrasound, or spinning disk) unless they are subjected to high-level disinfection and filled only with sterile water (*27,37,201,220*). Category IB

VII. Cooling Towers and Evaporative Condensers

A. When planning construction of new health-care facilities, locate cooling towers so that the drift is directed away from the air-intake system, and design the towers to minimize the volume of aerosol drift (*153,203,221*). Category IC (ASHRAE 12-2000)

B. Implement infection-control procedures for operational cooling towers (*153,203,222*). Category IC (ASHRAE 12-2000)
1. Install drift eliminators (*153,203,222*). Category IC (ASHRAE 12-2000)
2. Use an effective EPA-registered biocide on a regular basis (*153*). Category IC (ASHRAE 12-2000)
3. Maintain towers according to manufacturers' recommendations, and keep detailed maintenance and infection-control records, including environmental test results from legionellosis outbreak investigations (*153*). Category IC (ASHRAE 12-2000)

C. If cooling towers or evaporative condensers are implicated in health-care–associated legionellosis, decontaminate the cooling-tower system (*199,203,221,223*). Category IB

VIII. Dialysis Water Quality and Dialysate

A. Adhere to current AAMI standards for quality-assurance performance of devices and equipment used to treat, store, and distribute water in hemodialysis centers (both acute and maintenance [chronic] settings) and for the preparation of concentrates and dialysate (*224–235*). Category IA, IC (AAMI: American National Standards Institute [ANSI]/AAMI RD5:1992, ANSI/AAMI RD47:1993)

B. No recommendation is offered regarding whether more stringent requirements for water quality should be imposed in hemofiltration and hemodiafiltration. Unresolved issue

C. Conduct microbiologic testing specific to water in dialysis settings (*229,230,236–238*). Category IA, IC (AAMI: ANSI/AAMI RD5:1992, ANSI/AAMI RD47:1993, RD62:2001)
1. Perform bacteriologic assays of water and dialysis fluids at least once a month and during outbreaks by using standard quantitative methods (*236–238*). Category IA, IC (AAMI: ANSI/AAMI RD62:2001)
   a. Assay for heterotrophic, mesophilic bacteria (e.g., *Pseudomonas* spp).
   b. Do not use nutrient-rich media (e.g., blood agar or chocolate agar).
2. In conjunction with microbiologic testing, perform endotoxin testing on product water used to reprocess dialyzers for multiple use

(*229,230,239–242*). Category IA, IC (AAMI: ANSI/AAMI RD5:1992, ANSI/AAMI RD47:1993)

3. Ensure that water does not exceed the limits for microbial counts and endotoxin concentrations (Table 2) (*229–231*). Category IA, IC (AAMI: ANSI/AAMI RD5:1992, ANSI/AAMI RD47:1993)

D. Disinfect water distribution systems in dialysis settings at least weekly (*226–228,231,236*). Category IA, IC (AAMI: ANSI/AAMI RD62:2001)

E. Wherever practical, design and engineer water systems in dialysis settings to avoid incorporating joints, dead-end pipes, and unused branches and taps that can harbor bacteria (*226– 228,231,236*). Category IA, IC (AAMI: ANSI/AAMI RD62:2001)

F. When storage tanks are used in dialysis systems, they should be routinely drained, disinfected with an EPA-registered product, and fitted with an ultrafilter or pyrogenic filter (membrane filter with a pore size sufficient to remove particles and molecules ≥1 kilodalton) installed in the water line distal to the storage tank (*236*). Category IC (AAMI: ANSI/AAMI RD62:2001)

TABLE 2. Microbiologic limits for hemodialysis fluids

Hemodialysis fluid	Maximum total heterotrophs (CFU/mL*)	Maximum endotoxin level (EU/mL†)
Present standards		
Product water§		
Used to prepare dialysate	200	No standard
Used to reprocess dialyzers	200	5
Dialysate	2,000	No standard
Proposed standards¶		
Product water	200	2
Dialysate	200	2

Sources: American National Standards Institute, Association for the Advancement of Medical Instrumentation. Hemodialysis Systems. ANSI/AAMI RD5-1992. Arlington, VA: Association for the Advancement of Medical Instrumentation, 1993.
American National Standards Institute, Association for the Advancement of Medical Instrumentation. Reuse of hemodialyzers. ANSI/AAMI RD47-1993. Arlington, VA: Association for the Advancement of Medical Instrumentation, 1993.

* Colony forming units/milliliter.
† Endotoxin units/milliliter.
§ Product water presently includes water used to prepare dialysate and water used for reprocessing dialyzers.
¶ Dialysate for hemodialysis, RD52, under development, American National Standards Institute, Association for the Advancement of Medical Instrumentation (AAMI).

IX. Ice Machines and Ice

A. Do not handle ice directly by hand, and wash hands before obtaining ice. Category II

B. Use a smooth-surface ice scoop to dispense ice (*243,244*). Category II

1. Keep the ice scoop on a chain short enough that the scoop cannot touch the floor or keep the scoop on a clean, hard surface when not in use (*243,244*). Category II
2. Do not store the ice scoop in the ice bin. Category II

C. Do not store pharmaceuticals or medical solutions on ice intended for consumption; use sterile ice to keep medical solutions cold, or use equipment specifically manufactured for this purpose (*244,245*). Category IB

D. Machines that dispense ice are preferred to those that require ice to be removed from bins or chests with a scoop (*246,247*). Category II

E. Limit access to ice-storage chests, and keep container doors closed except when removing ice (*244*). Category II

F. Clean, disinfect, and maintain ice-storage chests on a regular basis. Category II

1. Follow the manufacturer's instructions for cleaning. Category II
2. Use an EPA-registered disinfectant suitable for use on ice machines, dispensers, or storage chests in accordance with label instructions. Category II
3. If instructions and EPA-registered disinfectants suitable for use on ice machines are not available, use a general cleaning/disinfecting regimen (Box 3) (*244*). Category II
4. Flush and clean ice machines and dispensers if they have not been disconnected before anticipated lengthy water disruptions. Category II

G. Install proper air gaps where the condensate lines meet the waste lines. Category II.

H. Conduct microbiologic sampling of ice, ice chests, and ice-making machines and dispensers where indicated during an epidemiologic investigation (*244,248,249*). Category IB

X. Hydrotherapy Tanks and Pools

A. Drain and clean hydrotherapy equipment (e.g., Hubbard tanks, tubs, whirlpools, whirlpool spas, or birthing tanks) after each patient's use, and disinfect equipment surfaces and components by using an EPA-registered product in accordance with the manufacturer's instructions. Category II

BOX 3 . General steps for cleaning and maintaining ice machines, dispensers, and storage chests*

1. Disconnect unit from power supply.
2. Remove and discard ice from bin or storage chest.
3. Allow unit to warm to room temperature.
4. Disassemble removable parts of machine that make contact with water to make ice.
5. Thoroughly clean machine and parts with water and detergent.
6. Dry external surfaces of removable parts before reassembling.
7. Check for any needed repair.
8. Replace feeder lines as appropriate (e.g., when damaged, old, or difficult to clean).
9. Ensure presence of an air space in tubing leading from water inlet into water distribution system of machine.
10. Inspect for rodent or insect infestations under the unit and treat as needed.
11. Check door gaskets (open compartment models) for evidence of leakage or dripping into the storage chest.
12. Clean the ice-storage chest or bin with fresh water and detergent; rinse with fresh tap water.
13. Sanitize machine by circulating a 50–100 parts per million (ppm) solution of sodium hypochlorite (i.e., 4–8 mL sodium hypochlorite/gallon of water) through the ice-making and storage systems for 2 hours (100 ppm solution), or 4 hours (50 ppm solution).
14. Drain sodium hypochlorite solution and flush with fresh tap water.
15. Allow all surfaces of equipment to dry before returning to service.

Source: Adapted from Manangan LP, Anderson RL, Arduino MJ, Bond WW. Sanitary care and maintenance of ice-storage chests and ice-making machines in health care facilities. Am J Infect Control 1998;26:111-2.
* These general instructions should be used only where manufacturer-recommended methods and EPA-registered disinfectants are not available.

B. In the absence of an EPA-registered product for water treatment, add sodium hypochlorite to the water:
   1. Maintain a 15-ppm chlorine residual in the water of small hydrotherapy tanks, Hubbard tanks, and tubs (*250*). Category II
   2. Maintain a 2–5-ppm chlorine residual in the water of whirlpools and whirlpool spas (*251*). Category II
   3. If the pH of the municipal water is in the basic range (e.g., when chloramine is used as the primary drinking water disinfectant in the community), consult the facility engineer regarding the possible need to adjust the pH of the water to a more acidic level before disinfection, to enhance the biocidal activity of the chlorine (*252*). Category II

C. Clean and disinfect hydrotherapy equipment after using tub liners. Category II

D. Clean and disinfect inflatable tubs unless they are single-use equipment. Category II

E. No recommendation is offered regarding the use of antiseptic chemicals (e.g., chloramine-T) in the water during hydrotherapy sessions. Unresolved issue

F. Conduct a risk assessment of patients before their use of large hydrotherapy pools, deferring patients with draining wounds or fecal incontinence from pool use until their condition resolves. Category II

G. For large hydrotherapy pools, use pH and chlorine residual levels appropriate for an indoor pool as provided by local and state health agencies. Category IC (States)

H. No recommendation is offered regarding the use in health-care settings of whirlpool or spa equipment manufactured for home or recreational use. Unresolved issue

XI. Miscellaneous Medical Equipment Connected to Water Systems

A. Clean, disinfect, and maintain AER equipment according to the manufacturer's instructions and relevant scientific literature to prevent inadvertent contamination of endoscopes and bronchoscopes with waterborne microorganisms (*253–257*). Category IB
   1. To rinse disinfected endoscopes and bronchoscopes, use water of the highest quality practical for the system's engineering and design (e.g., sterile water or bacteriologically filtered water [water filtered through 0.1–0.2-µm filters]) (*254,256–258*). Category IB
   2. Dry the internal channels of the reprocessed endoscope or bronchoscope by using a proven method (e.g., 70% alcohol followed by forced-air treatment) to lessen the potential for proliferation of waterborne microorganisms and to help prevent biofilm formation (*259–263*). Category IB

B. Use water that meets nationally recognized standards set by the EPA for drinking water (<500 CFU/mL for heterotrophic plate count) for routine dental

treatment output water (*264–267*). Category IC (EPA: 40 CFR 1 Part 141, Subpart G)

C. Take precautions to prevent waterborne contamination of dental unit water lines and instruments.
   1. After each patient, discharge water and air for a minimum of 20–30 seconds from any dental device connected to the dental water system that enters a patient's mouth (e.g., handpieces, ultrasonic scalers, or air/water syringes) (*265,268*). Category II
   2. Consult with dental water-line manufacturers to 1) determine suitable methods and equipment to obtain the recommended water quality; and 2) determine appropriate methods for monitoring the water to ensure quality is maintained (*265,269*). Category II
   3. Consult with the dental unit manufacturer regarding the need for periodic maintenance of antiretraction mechanisms (*268,269*). Category IB

Recommendations — Environmental Services

I. Cleaning and Disinfecting Strategies for Environmental Surfaces in Patient-Care Areas

A. Select EPA-registered disinfectants, if available, and use them in accordance with the manufacturer's instructions (*270–272*). Category IC (EPA: 7 United States Code [USC] § 136 et seq.)

B. Do not use high-level disinfectants/liquid chemical sterilants for disinfection of either noncritical instruments and devices or any environmental surfaces; such use is counter to label instructions for these toxic chemicals (*273–278*). Category IC (Food and Drug Administration [FDA]: 21 CFR 801.5, 807.87.e)

C. Follow manufacturers' instructions for cleaning and maintaining noncritical medical equipment. Category II

D. In the absence of a manufacturer's cleaning instructions, follow certain procedures.
   1. Clean noncritical medical equipment surfaces with a detergent/disinfectant. This may be followed by an application of an EPA-registered hospital disinfectant with or without a tuberculocidal claim (depending on the nature of the surface and the degree of contamination), in accordance with germicide label instructions (*274*). Category II

2. Do not use alcohol to disinfect large environmental surfaces (*273*). Category II
3. Use barrier protective coverings as appropriate for noncritical surfaces that are 1) touched frequently with gloved hands during the delivery of patient care; 2) likely to become contaminated with blood or body substances; or 3) difficult to clean (e.g., computer keyboards) (*265*). Category II

E. Keep housekeeping surfaces (e.g., floors, walls, tabletops) visibly clean on a regular basis and clean up spills promptly (*279*). Category II
1. Use a one-step process and an EPA-registered hospital detergent/disinfectant designed for general housekeeping purposes in patient-care areas where 1) uncertainty exists as to the nature of the soil on the surfaces (e.g., blood or body fluid contamination versus routine dust or dirt); or 2) uncertainty exists regarding the presence of multidrug resistant organisms on such surfaces (*272,274,280,281*). Category II
2. Detergent and water are adequate for cleaning surfaces in nonpatient-care areas (e.g., administrative offices). Category II
3. Clean and disinfect high-touch surfaces (e.g., doorknobs, bed rails, light switches, and surfaces in and around toilets in patients' rooms) on a more frequent schedule than minimal-touch housekeeping surfaces. Category II
4. Clean walls, blinds, and window curtains in patient-care areas when they are visibly dusty or soiled (*270,282–284*). Category II

F. Do not perform disinfectant fogging in patient-care areas (*270,285*). Category IB

G. Avoid large-surface cleaning methods that produce mists or aerosols, or disperse dust in patient-care areas (*37,48,51,73*). Category IB

H. Follow proper procedures for effective uses of mops, cloths, and solutions. Category II
1. Prepare cleaning solutions daily or as needed, and replace with fresh solution frequently according to facility policies and procedures (*280,281*). Category II
2. Change the mop head at the beginning of each day and also as required by facility policy, or after cleaning up large spills of blood or other body substances. Category II
3. Clean mops and cloths after use and allow to dry before reuse; or use single-use, disposable mop heads and cloths (*282,286–288*). Category II

I. After the last surgical procedure of the day or night, wet vacuum or mop operating room floors with a single-use mop and an EPA-registered hospital disinfectant (*114*). Category IB

J. Do not use mats with tacky surfaces at the entrances to operating rooms or infection-control suites (*114*). Category IB

K. Use appropriate dusting methods for patient-care areas designated for immunocompromised patients (e.g., HSCT patients) (*37,40,280*). Category IB
1. Wet-dust horizontal surfaces daily by moistening a cloth with a small amount of an EPA-registered hospital detergent/disinfectant (*37,40,280*). Category IB
2. Avoid dusting methods that disperse dust (e.g., feather-dusting) (*40*). Category IB

L. Keep vacuums in good repair and equip vacuums with HEPA filters for use areas with patients at risk (*37,40,280,289*). Category IB

M. Close the doors of immunocompromised patients' rooms when vacuuming, waxing, or buffing corridor floors to minimize exposure to airborne dust (*37,40,289*). Category IB

N. When performing low- or intermediate-level disinfection of environmental surfaces in nurseries and neonatal units, avoid unnecessary exposure of neonates to disinfectant residues on these surfaces by using EPA-registered germicides in accordance with manufacturers' instructions and safety advisories (*271,290–292*). Category IB, IC (EPA: 7 USC § 136 et seq.)
1. Do not use phenolics or any other chemical germicide to disinfect bassinets or incubators during an infant's stay (*271,290–292*). Category IB
2. Rinse disinfectant-treated surfaces, especially those treated with phenolics, with water (*290–292*). Category IB

O. When using phenolic disinfectants in neonatal units, prepare solutions to correct concentrations in accordance with manufacturers' instructions, or use premixed formulations (*271,290–292*). Category IB, IC (EPA: 7 USC § 136 et seq.)

II. Cleaning Spills of Blood and Body Substances

A. Promptly clean and decontaminate spills of blood or other potentially infectious materials (*293–300*). Category IB, IC (OSHA: 29 CFR 1910.1030 § d.4.ii.A)

B. Follow proper procedures for site decontamination of spills of blood or blood-containing body fluids

(*293–300*). Category IC (OSHA: 29 CFR 1910.1030 § d.4.ii.A)

1. Use protective gloves and other PPE appropriate for this task (*293*). Category IC (OSHA: 29 CFR 1910.1030 § d.3.i, ii)
2. If the spill contains large amounts of blood or body fluids, clean the visible matter with disposable absorbent material, and discard the used cleaning materials in appropriate, labeled containers (*293,298,299,301,302*). Category IC (OSHA: 29 CFR 1910.1030 § d.4.iii.B)
3. Swab the area with a cloth or paper towels moderately wetted with disinfectant, and allow the surface to dry (*293,301*). Category IC (OSHA: 29 CFR 1910.1030 § d.4.ii.A)

C. Use germicides registered by the EPA for use as hospital disinfectants and labeled tuberculocidal or registered germicides on the EPA Lists D and E (i.e., products with specific label claims for HIV or hepatitis B virus [HBV]) in accordance with label instructions to decontaminate spills of blood and other body fluids (*293,301,303*). Category IC (OSHA 29 CFR 1910.1030 § d.4.ii. A memorandum 2/28/97; compliance document [CPL] 2-2.44D [11/99])

D. An EPA-registered sodium hypochlorite product is preferred, but if such products are not available, generic sodium hypochlorite solutions (e.g., household chlorine bleach) may be used.

1. Use a 1:100 dilution (500–615 ppm available chlorine) to decontaminate nonporous surfaces after cleaning a spill of either blood or body fluids in patient-care settings (*301,304*). Category IB
2. If a spill involves large amounts of blood or body fluids, or if a blood or culture spill occurs in the laboratory, use a 1:10 dilution (5,000–6,150 ppm available chlorine) for the first application of germicide before cleaning (*279,301*). Category IB

III. Carpeting and Cloth Furnishings

A. Vacuum carpeting in public areas of health-care facilities and in general patient-care areas regularly with well-maintained equipment designed to minimize dust dispersion (*280*). Category II

B. Periodically perform a thorough, deep cleaning of carpeting as determined by facility policy by using a method that minimizes the production of aerosols and leaves little or no residue (*44*). Category II

C. Avoid use of carpeting in high-traffic zones in patient-care areas or where spills are likely (e.g., burn therapy units, operating rooms, laboratories, or intensive care units) (*44,305,306*). Category IB

D. Follow appropriate procedures for managing spills on carpeting.

1. Spot-clean blood or body substance spills promptly (*293,301,304,307*). Category IC (OSHA: 29 CFR 1910.1030 § d.4.ii.A, interpretation)
2. If a spill occurs on carpet tiles, replace any tiles contaminated by blood and body fluids or body substances (*307*). Category IC (OSHA 29 CFR 1910.1030 § d.4.ii interpretation)

E. Thoroughly dry wet carpeting to prevent the growth of fungi; replace carpeting that remains wet after 72 hours (*37,160*). Category IB

F. No recommendation is offered regarding the routine use of fungicidal or bactericidal treatments for carpeting in public areas of a health-care facility or in general patient-care areas. Unresolved issue

G. Do not use carpeting in hallways and patient rooms in areas housing immunosuppressed patients (e.g., PE areas) (*37,44*). Category IB

H. Avoid using upholstered furniture and furnishings in high-risk patient-care areas and in areas with increased potential for body substance contamination (e.g., pediatrics units) (*37*). Category II

I. No recommendation is offered regarding whether upholstered furniture and furnishings should be avoided in general patient-care areas. Unresolved issue

1. Maintain upholstered furniture in good repair. Category II
2. Maintain the surface integrity of the upholstery by repairing tears and holes. Category II
3. If upholstered furniture in a patient's room requires cleaning to remove visible soil or body substance contamination, move that item to a maintenance area where it can be adequately cleaned with a process appropriate for the type of upholstery and nature of the soil. Category II

IV. Flowers and Plants in Patient-Care Areas

A. Flowers and potted plants need not be restricted from areas for immunocompetent patients (*308–311*). Category II

B. Designate care and maintenance of flowers and potted plants to staff not directly involved with patient care (*309*). Category II

C. If plant or flower care by patient-care staff is unavoidable, instruct the staff to wear gloves when handling plants and flowers and perform hand hygiene after glove removal (*309*). Category II

D. Do not allow fresh or dried flowers, or potted plants, in patient-care areas for immunosuppressed patients (*37,51,308,312*). Category II

V. Pest Control

A. Develop pest-control strategies, with emphasis on kitchens, cafeterias, laundries, central sterile supply areas, operating rooms, loading docks, construction activities, and other areas prone to infestations (*313–315*). Category II

B. Install screens on all windows that open to the outside; keep screens in good repair (*314*). Category IB

C. Contract for routine pest control service by a credentialed pest-control specialist who will tailor the application to the needs of a health-care facility (*315*). Category II

D. Place laboratory specimens (e.g., fixed sputum smears) in covered containers for overnight storage (*316,317*). Category II

VI. Special Pathogens

A. Use appropriate hand hygiene, PPE (e.g., gloves), and isolation precautions during cleaning and disinfecting procedures (*146,274,318,319*). Category IB

B. Use standard cleaning and disinfection protocols to control environmental contamination with antibiotic-resistant, gram-positive cocci (e.g., methicillin-resistant *Staphylococcus aureus*, vancomycin intermediate sensitive *Staphylococcus aureus*, or vancomycin-resistant *Enterococcus* [VRE]) (*318,320–322*). Category IB

1. Pay close attention to cleaning and disinfection of high-touch surfaces in patient-care areas (e.g., bed rails, carts, charts, bedside commodes, bed rails, doorknobs, or faucet handles) (*318,320–322*). Category IB
2. Ensure compliance by housekeeping staff with cleaning and disinfection procedures (*318,320–322*). Category IB
3. Use EPA-registered chemical germicides appropriate for the surface to be disinfected (e.g., either low- or intermediate-level disinfection) as specified by the manufacturer's instructions (*271,322–327*). Category IB, IC (EPA: 7 USC § 136 et seq.)
4. When contact precautions are indicated for patient care, use disposable patient-care items (e.g., blood pressure cuffs) wherever possible to minimize cross-contamination with multiple-resistant microorganisms (*328*). Category IB
5. Follow these same surface-cleaning and disinfecting measures for managing the environment of VRSA patients (*320–322,327*). Category II

C. Environmental-surface culturing can be used to verify the efficacy of hospital policies and procedures before and after cleaning and disinfecting rooms that house patients with VRE (*318,329–333*). Category II

1. Obtain prior approval from infection-control staff and the clinical laboratory before performing environmental-surface culturing. Category II
2. Infection-control staff, with clinical laboratory staff consultation, must supervise all environmental culturing. Category II

D. Thoroughly clean and disinfect environmental and medical equipment surfaces on a regular basis by using EPA-registered disinfectants in accordance with manufacturers' instructions (*271,274,319,334*). Category IB, IC (EPA: 7 USC § 136 et seq.)

E. Advise families, visitors, and patients regarding the importance of hand hygiene to minimize the spread of body substance contamination (e.g., respiratory secretions or fecal matter) to surfaces (*274*). Category II

F. Do not use high-level disinfectants (i.e., liquid chemical sterilants) on environmental surfaces; such use is inconsistent with label instructions because of the toxicity of the chemicals (*270,273,274,278*). Category IC (FDA: 21 CFR 801.5, 807.87.e)

G. Because no EPA-registered products are specific for inactivating *Clostridium difficile* spores, use hypochlorite-based products for disinfection of environmental surfaces in accordance with guidance from the scientific literature in those patient-care areas where surveillance and epidemiology indicate ongoing transmission of *C. difficile* (*274,319,334*). Category II

H. No recommendation is offered regarding the use of specific EPA-registered hospital disinfectants with respect to environmental control of *C. difficile*. Unresolved issue

I. Apply standard cleaning and disinfection procedures to control environmental contamination with res-

piratory and enteric viruses in pediatric-care units and care areas for immunocompromised patients (*280,335*). Category IC (EPA: 7 USC § 136 et seq.)

J. Clean surfaces that have been contaminated with body substances; perform low- to intermediate-level disinfection on cleaned surfaces with an EPA-registered disinfectant in accordance with the manufacturer's instructions (*271,293,335*). Category IC (OSHA: 29 CFR 1910.1030 § d.4.ii.A; EPA: 7 USC § 136 et seq.)

K. Use disposable barrier coverings as appropriate to minimize surface contamination. Category II

L. Develop and maintain cleaning and disinfection procedures in patient-care areas to control environmental contamination with agents of Creutzfeldt-Jakob disease (CJD), for which no EPA-registered product exists. Category II

1. In the absence of contamination with central nervous system tissue, extraordinary measures (e.g., use of 2N sodium hydroxide [NaOH] or applying full-strength sodium hypochlorite) are not needed for routine cleaning or terminal disinfection of a room housing a confirmed or suspected CJD patient (*273,336*). Category II
2. After removing gross tissue from the surface, use either 1N NaOH or a sodium hypochlorite solution containing approximately 10,000–20,000 ppm available chlorine (dilutions of 1:5 to 1:3 v/v, respectively, of U.S. household chlorine bleach; contact the manufacturers of commercially available sodium hypochlorite products for advice) to decontaminate operating room or autopsy surfaces with central nervous system or cerebral spinal fluid contamination from a diagnosed or suspected CJD patient (*273,337–342*). Category II
   a. The contact time for the chemical used during this process should be 30 min–1 hour (*339,340,342*).
   b. Blot up the chemical with absorbent material and rinse the treated surface thoroughly with water.
   c. Discard the used, absorbent material into appropriate waste containers.
3. Use disposable, impervious covers to minimize body substance contamination to autopsy tables and surfaces (*340,342*). Category II

M. Use standard procedures for containment, cleaning, and decontamination of blood spills on surfaces as previously described (Environmental Services: II) (*293*). Category IC (OSHA: 29 CFR 1910.1030 § d.4.ii.A)

1. Wear PPE appropriate for a surface decontamination and cleaning task (*293,336*). Category IC (OSHA 29 CFR 1910.1030 § d.3.i, ii)
2. Discard used PPE by using routine disposal procedures or decontaminate reusable PPE as appropriate (*293,336*). Category IC (OSHA 29 CFR 1910.1030 § d.3.viii)

Recommendations — Environmental Sampling

I. General Information

A. Do not conduct random, undirected, microbiologic sampling of air, water, and environmental surfaces in health-care facilities (*270,343*). Category IB

B. When indicated, conduct microbiologic sampling as part of an epidemiologic investigation or during assessment of hazardous environmental conditions to detect contamination or verify abatement of a hazard (*270,343*). Category IB

C. Limit microbiologic sampling for quality assurance purposes to 1) biologic monitoring of sterilization processes; 2) monthly cultures of water and dialysate in hemodialysis units; and 3) short-term evaluation of the impact of infection-control measures or changes in infection-control protocols (*270,343*). Category IB

II. Air, Water, and Environmental Surface Sampling

A. When conducting any form of environmental sampling, identify existing comparative standards and fully document departures from standard methods (*343–347*). Category II

B. Select a high-volume air sampling device if anticipated levels of microbial airborne contamination are expected to be low (*345,346,348,349*). Category II

C. Do not use settle plates to quantify the concentration of airborne fungal spores (*348*). Category II

D. When sampling water, choose growth media and incubation conditions that will facilitate recovery of waterborne organisms (*344*). Category II

E. When using a sample/rinse method for sampling an environmental surface, develop and document a

procedure for manipulating the swab, gauze, or sponge in a reproducible manner so that results are comparable (*347*). Category II

F. When environmental samples and patient specimens are available for comparison, perform the laboratory analysis on the recovered microorganisms down to the species level at a minimum, and beyond the species level if possible (*343*). Category II

Recommendations — Laundry and Bedding

I. Employer Responsibilities

A. Employers must launder workers' personal protective garments or uniforms that are contaminated with blood or other potentially infectious materials (*293*). Category IC (OSHA: 29 CFR 1910.1030 § d.3.iv)

II. Laundry Facilities and Equipment

A. Maintain the receiving area for contaminated textiles at negative pressure compared with the clean areas of the laundry in accordance with AIA construction standards in effect during the time of facility construction (*1,350–352*). Category IC (AIA: 7.23.B1, B2)

B. Ensure that laundry areas have handwashing facilities and products and appropriate PPE available for workers (*1,293*). Category IC (AIA: 7.23.D4; OSHA: 29 CFR 1910.1030 § d.2.iii)

C. Use and maintain laundry equipment according to manufacturers' instructions (*353,354*). Category II

D. Do not leave damp textiles or fabrics in machines overnight (*353*). Category II

E. Disinfection of washing and drying machines in residential care is not needed as long as gross soil is removed from items before washing and proper washing and drying procedures are used. Category II

III. Routine Handling of Contaminated Laundry

A. Handle contaminated textiles and fabrics with minimum agitation to avoid contamination of air, surfaces, and persons (*36,293,355,356*). Category IC (OSHA: 29 CFR 1910.1030 § d.4.iv)

B. Bag or otherwise contain contaminated textiles and fabrics at the point of use (*293*). Category IC (OSHA: 29 CFR 1910.1030 § d.4.iv)

1. Do not sort or prerinse contaminated textiles or fabrics in patient-care areas (*293*). Category IC (OSHA: 29 CFR 1910.1030 § d.4.iv)
2. Use leak-resistant containment for textiles and fabrics contaminated with blood or body substances (*293,355*). Category IC (OSHA: 29 CFR 1910.1030 § d.4.iv)
3. Identify bags or containers for contaminated textiles with labels, color coding, or other alternative means of communication as appropriate (*293*). Category IC (OSHA: 29 CFR 1910.1030 § d.4.iv)

C. Covers are not needed on contaminated textile hampers in patient-care areas. Category II

D. If laundry chutes are used, ensure that they are properly designed, maintained, and used in a manner to minimize dispersion of aerosols from contaminated laundry (*357–361*). Category IC (AAMI: ANSI/AAMI ST65:2000)

1. Ensure that laundry bags are closed before tossing the filled bag into the chute. Category II
2. Do not place loose items in the laundry chute. Category II

E. Establish a facility policy to determine when textiles or fabrics should be sorted in the laundry facility (i.e., before or after washing) (*362,363*). Category II

IV. Laundry Process

A. If hot-water laundry cycles are used, wash with detergent in water ≥160°F (≥71°C) for ≥25 minutes (*1,270*). Category IC (AIA: 7.31.E3)

B. No recommendation is offered regarding a hot-water temperature setting and cycle duration for items laundered in residence-style health-care facilities. Unresolved issue

C. Follow fabric-care instructions and special laundering requirements for items used in the facility (*364*). Category II

D. Choose chemicals suitable for low-temperature washing at proper use concentration if low-temperature (<160°F [<70°C]) laundry cycles are used (*365–370*). Category II

E. Package, transport, and store clean textiles and fabrics by methods that will ensure their cleanliness and protect them from dust and soil during interfacility loading, transport, and unloading (*270*). Category II

V. Microbiologic Sampling of Textiles

A. Do not conduct routine microbiologic sampling of clean textiles (*270,371*). Category IB

B. Use microbiologic sampling during outbreak investigations if epidemiologic evidence indicates a role for health-care textiles and clothing in disease transmission (*371*). Category IB

VI. Special Laundry Situations

A. Use sterilized textiles, surgical drapes, and gowns for situations requiring sterility in patient care (*114*). Category IB

B. Use hygienically clean textiles (i.e., laundered, but not sterilized) in neonatal intensive care units (*292,372*). Category IB

C. Follow manufacturers' recommendations for cleaning fabric products, including those with coated or laminated surfaces. Category II

D. Do not use dry cleaning for routine laundering in health-care facilities (*373–375*). Category II

E. Use caution when considering use of antimicrobial mattresses, textiles, and clothing as replacements for standard bedding and other fabric items; EPA has not approved public health claims asserting protection against human pathogens for such treated items (*376*). Category II

F. No recommendation is offered regarding using disposable fabrics and textiles versus durable goods. Unresolved issue

VII. Mattresses and Pillows

A. Keep mattresses dry; discard them if they remain wet or stained, particularly in burn units (*377–382*). Category IB

B. Clean and disinfect mattress covers by using EPA-registered disinfectants that are compatible with the materials to prevent the development of tears, cracks, or holes in the covers (*377–382*). Category IB

C. Maintain the integrity of mattress and pillow covers. Category II

1. Replace mattress and pillow covers if they become torn or otherwise in need of repair. Category II
2. Do not stick needles into a mattress through the cover. Category II

D. Clean and disinfect moisture-resistant mattress covers between patient use by using an EPA-registered product (*377–382*). Category IB

E. If using a mattress cover completely made of fabric, change these covers and launder between patient use (*377–382*). Category IB

F. Launder pillow covers and washable pillows in the hot-water cycle between patients or when they become contaminated with body substances (*382*). Category IB

VIII. Air-Fluidized Beds

A. Follow manufacturers' instructions for air-fluidized bed maintenance and decontamination. Category II

B. Change the polyester filter sheet at least weekly or as indicated by the manufacturer (*383–386*). Category II

C. Clean and disinfect the polyester filter sheet thoroughly, especially between patients, using an EPA-registered product (*383–386*). Category IB

D. Consult the facility engineer to determine the proper placement of air-fluidized beds in negative-pressure rooms (*387*). Category II

Recommendations — Animals in Health-Care Facilities

I. General Infection-Control Measures for Animal Encounters

A. Minimize contact with animal saliva, dander, urine, and feces (*388–390*). Category II

B. Practice hand hygiene after any animal contact (*146,270*). Category II

1. Wash hands with soap and water, especially if hands are visibly soiled or contaminated with proteinaceous material (*146*). Category II
2. Use either soap and water or alcohol-based hand rubs when hands are not visibly soiled or contaminated (*146*). Category II

II. Animal-Assisted Activities and Resident Animal Programs

A. Avoid selection of nonhuman primates and reptiles in animal-assisted activities, animal-assisted therapy, or resident animal programs (*391–393*). Category IB

B. Enroll animals that are fully vaccinated for zoonotic diseases and that are healthy, clean, well-groomed, and negative for enteric parasites or otherwise have completed recent anthelmintic treatment under the regular care of a veterinarian (*391,394*). Category II

C. Enroll animals that are trained with the assistance or under the direction of persons who are experienced in this field (*391*). Category II

D. Ensure that animals are controlled by persons trained in providing activities or therapies safely, and who know the animal's health status and behavior traits (*391,394*). Category II

E. Take prompt action when an incident of biting or scratching by an animal occurs during an animal-assisted activity or therapy.

1. Remove the animal permanently from these programs (*391*). Category II

2. Report the incident promptly to appropriate authorities (e.g., infection-control staff, animal program coordinator, or local animal control personnel) (*391*). Category II
3. Promptly clean and treat scratches, bites, or other breaks in the skin. Category II

F. Perform an ICRA and work actively with the animal handler before conducting an animal-assisted activity or therapy to determine whether the session should be held in a public area of the facility or in individual patient rooms (*391,394*). Category II

G. Take precautions to mitigate allergic responses to animals. Category II
1. Minimize shedding of animal dander by bathing animals <24 hours before a visit (*391*). Category II
2. Groom animals to remove loose hair before a visit, or use a therapy animal cape (*395*). Category II

H. Use routine cleaning protocols for housekeeping surfaces after therapy sessions. Category II

I. Restrict resident animals, including fish in tanks, from access to patient-care areas, food-preparation areas, dining areas, laundry, central sterile supply areas, sterile and clean supply storage areas, medication preparation areas, operating rooms, isolation areas, and PE areas. Category II

J. Establish a facility policy for regular cleaning of fish tanks, rodent cages, and bird cages, and any other animal dwellings and assign this cleaning task to a nonpatient-care staff member; avoid splashing tank water or contaminating environmental surfaces with animal bedding. Category II

III. Protective Measures for Immunocompromised Patients

A. Advise patients to avoid contact with animal feces, saliva, urine, or solid litter box material (*396*). Category II

B. Promptly clean and treat scratches, bites, or other wounds that break the skin (*396*). Category II

C. Advise patients to avoid direct or indirect contact with reptiles (*397*). Category IB

D. Conduct a case-by-case assessment to determine if animal-assisted activities or animal-assisted therapy programs are appropriate for immunocompromised patients (*394*). Category II

E. No recommendation is offered regarding permitting pet visits to terminally ill immunocompromised patients outside their PE units. Unresolved issue.

IV. Service Animals

A. Avoid providing facility access to nonhuman primates and reptiles as service animals (*393,397*). Category IB

B. Allow service animals access to the facility in accordance with the Americans with Disabilities Act of 1990, unless the presence of the animal creates a direct threat to other persons or a fundamental alteration in the nature of services (*389,398*). Category IC (U.S. Department of Justice: 28 CFR § 36.302)

C. When a decision must be made regarding a service animal's access to any particular area of the health-care facility, evaluate the service animal, patient, and health-care situation on a case-by-case basis to determine whether significant risk of harm exists and whether reasonable modifications in policies and procedures will mitigate this risk (*398*). Category IC (U.S. Department of Justice: 28 CFR § 36.208)

D. If a patient must be separated from his or her service animal while in the health-care facility 1) ascertain from the person what arrangements have been made for supervision or care of the animal during this period of separation; and 2) make appropriate arrangements to address the patient's needs in the absence of the service animal. Category II

V. Animals as Patients in Human Health-Care Facilities

A. Develop health-care facility policies to address the treatment of animals in human health-care facilities.
1. Use the multidisciplinary team approach to policy development, including public media relations efforts to disclose and discuss these activities. Category II
2. Exhaust all veterinary facility, equipment, and instrument options before undertaking the procedure. Category II
3. Ensure that the care of the animal is supervised by a licensed veterinarian. Category II

B. When animals are treated in human health-care facilities, avoid treating animals in operating rooms or other patient-care areas where invasive procedures are performed (e.g., cardiac catheterization laboratories or invasive nuclear medicine areas). Category II

C. Schedule the animal procedure for the last procedure of the day in the area, at a time when human patients are not scheduled to be in the vicinity. Category II

D. Adhere strictly to standard precautions. Category II
E. Clean and disinfect environmental surfaces thoroughly by using an EPA-registered product in the room after the animal has been removed. Category II
F. Allow sufficient ACH to clean the air and help remove airborne dander, microorganisms, and allergens (Table 1). Category II
G. Clean and disinfect using EPA-registered products or sterilize equipment that has been in contact with the animal; or use disposable equipment. Category II
H. If reusable medical or surgical instruments are used in an animal procedure, restrict future use of these instruments to animals only. Category II

VI. Research Animals in Health-Care Facilities

A. Use animals obtained from quality stock, or quarantine incoming animals to detect zoonotic diseases. Category II
B. Treat sick animals or remove them from the facility. Category II
C. Provide prophylactic vaccinations, as available, to animal handlers and contacts at high risk. Category II
D. Ensure proper ventilation through appropriate facility design and location (*399*). Category IC (U.S. Department of Agriculture [USDA]: 7 USC 2131)
   1. Keep animal rooms at negative pressure relative to corridors (*399*). Category IC (USDA: 7 USC 2131)
   2. Prevent air in animal rooms from recirculating elsewhere in the health-care facility (*399*). Category IC (USDA: 7 USC 2131)
E. Keep doors to animal research rooms closed. Category II
F. Restrict access to animal facilities to essential personnel. Category II
G. Establish employee occupational health programs specific to the animal research facility, and coordinate management of postexposure procedures specific to zoonoses with occupational health clinics in the health-care facility (*400,401*). Category IC (U.S. Department of Health and Human Services [DHHS]: Biosafety in Microbiological and Biomedical Laboratories [BMBL]; OSHA: 29 CFR 1910.1030.132-139)
H. Document standard operating procedures for the unit (*400*). Category IC (DHHS: BMBL)
I. Conduct routine employee training on worker safety concerns relevant to the animal research facility (e.g., working safely with animals, animal handling) (*400,401*). Category IC (DHHS: BMBL; OSHA: 29 CFR 1910.1030.132–139)
J. Use precautions to prevent development of animal-induced asthma in animal workers (*400*). Category IC (DHHS: BMBL)

Recommendations — Regulated Medical Wastes

I. Categories of Regulated Medical Waste

A. Designate the following as major categories of medical waste that require special handling and disposal precautions: 1) microbiology laboratory wastes [e.g., cultures and stocks of microorganisms]; 2) bulk blood, blood products, blood, and bloody body fluid specimens; 3) pathology and anatomy waste; and 4) sharps [e.g., needles and scalpels] (*270*). Category II
B. Consult federal, state, and local regulations to determine if other waste items are considered regulated medical wastes (*293,402,403*). Category IC (States; OSHA: 29 CFR 1910.1030 § g.2.1; Department of Transportation [DOT]: 49 CFR 171-180; U.S. Postal Service: CO23.8)

II. Disposal Plan for Regulated Medical Wastes

A. Develop a plan for the collection, handling, predisposal treatment, and terminal disposal of regulated medical wastes (*293,404*). Category IC (States; OSHA: 29 CFR 1910.1030 § g.2.i)
B. Designate a person or persons as responsible for establishing, monitoring, reviewing, and administering the plan. Category II

III. Handling, Transporting, and Storing Regulated Medical Wastes

A. Inform personnel involved in handling and disposal of potentially infective waste of possible health and safety hazards; ensure that they are trained in appropriate handling and disposal methods (*293*). Category IC (OSHA: 29 CFR 1910.1030 § g.2.i)
B. Manage the handling and disposal of regulated medical wastes generated in isolation areas by using the same methods used for regulated medical wastes from other patient-care areas (*270*). Category II
C. Use proper sharps disposal strategies (*293*). Category IC (OSHA: 29 CFR 1910.1030 § d.4.iii.A)
   1. Use a sharps container capable of maintaining its impermeability after waste treatment to avoid subsequent physical injuries during final disposal (*293*). Category IC (OSHA: 29 CFR 1910.1030 § d.4.iii.A)

2. Place disposable syringes with needles, including sterile sharps that are being discarded, scalpel blades, and other sharp items into puncture-resistant containers located as close as practical to the point of use (*293*). Category IC (OSHA: 29 CFR 1910.1030 § d.4.iii.A)
3. Do not bend, recap, or break used syringe needles before discarding them into a container (*36,293,405*). Category IC (OSHA: 29 CFR 1910.1030 § d.2.vii and § d.2.vii.A)

D. Store regulated medical wastes awaiting treatment in a properly ventilated area inaccessible to vertebrate pests; use waste containers that prevent development of noxious odors. Category IC (States)

E. If treatment options are not available at the site where the medical waste is generated, transport regulated medical wastes in closed, impervious containers to the on-site treatment location or to another facility for treatment as appropriate. Category IC (States)

IV. Treatment and Disposal of Regulated Medical Wastes

A. Treat regulated medical wastes by using a method (e.g., steam sterilization, incineration, interment, or an alternative treatment technology) approved by the appropriate authority having jurisdiction (AHJ) (e.g., state, Indian Health Service, or Veterans Administration) before disposal in a sanitary landfill. Category IC (States, AHJ)

B. Follow precautions for treating microbiologic wastes (e.g., amplified cultures and stocks of microorganisms) (*400*). Category IC (DHHS: BMBL)
1. Biosafety level 4 laboratories must inactivate microbiologic wastes in the laboratory by using an approved inactivation method (e.g., autoclaving) before transport to and disposal in a sanitary landfill (*400*). Category IC (DHHS: BMBL)
2. Biosafety level 3 laboratories must inactivate microbiologic wastes in the laboratory by using an approved inactivation method (e.g., autoclaving) or incinerate them at the facility before transport to and disposal in a sanitary landfill (*400*). Category IC (DHHS: BMBL)

C. Biosafety levels 1 and 2 laboratories should develop strategies to inactivate amplified microbial cultures and stocks onsite by using an approved inactivation method (e.g., autoclaving) instead of packaging and shipping untreated wastes to an offsite facility for treatment and disposal (*400,406–408*). Category II

D. Laboratories that isolate select agents from clinical specimens must comply with federal regulations for receipt, transfer, management, and appropriate disposal of these agents (*409*). Category IC (DHHS: 42 CFR 72 § 72.6.i.1.iii)

E. Sanitary sewers may be used for safe disposal of blood, suctioned fluids, ground tissues, excretions, and secretions, provided that local sewage discharge requirements are met and that the state has declared this to be an acceptable method of disposal (*410*). Category II

V. Special Precautions for Wastes Generated During Care of Patients with Rare Diseases

A. When discarding items contaminated with blood and body fluids from VHF patients, contain these regulated medical wastes with minimal agitation during handling (*36,109*). Category II

B. Manage properly contained wastes from areas providing care to VHF patients in accordance with recommendations for other isolation areas (Regulated Medical Waste: III B) (*36,109,270*). Category II

C. Decontaminate bulk blood and body fluids from VHF patients by using approved inactivation methods (e.g., autoclaving or chemical treatment) before disposal (*36,109*). Category IC, II (States)

D. When discarding regulated medical waste generated during the routine (i.e., nonsurgical) care of CJD patients, contain these wastes and decontaminate them by using approved inactivation methods (e.g., autoclaving or incineration) appropriate for the medical waste category (e.g., blood, sharps, or pathological waste) (*36,270,273,336*). Category IC, II (States)

E. Incinerate medical wastes (e.g., central nervous system tissues or contaminated disposable materials) from brain autopsy or biopsy procedures of diagnosed or suspected CJD patients (*340,342*). Category IB

References

1. The American Institute of Architects and The Facilities Guidelines Institute. Guidelines for design and construction of hospital and health care facilities, 2001. Washington, DC: American Institute of Architects Press, 2001.
2. Arnow PM, Sadigh M, Costas C, Weil D, Chudy R. Endemic and epidemic aspergillosis associated with in-hospital replication of *Aspergillus* organisms. J Infect Dis 1991;164:998–1002.
3. Streifel AJ. Design and maintenance of hospital ventilation systems and the prevention of airborne nosocomial infections [Chapter 80]. In: Mayhall, CG, ed. Hospital epidemiology and infection control. 2nd ed. Philadelphia, PA: Lippincott Williams and Wilkins, 1999.
4. Pittet D, Huguenin T, Dharan S, et al. Unusual cause of lethal pulmonary aspergillosis in patients with chronic obstructive pulmonary disease. Am J Respir Crit Care Med 1996;154(2 Pt 1):541–4.

5. US Environmental Protection Agency, Office of Air and Radiation, and US Department of Health and Human Services, National Institute of Occupational Safety and Health. Building air quality: a guide for building owners and facility managers. Washington, DC: 1991; DHHS publication (NIOSH)91-114 and EPA/400/1–91/033. Available at http://www.cdc.gov/niosh/baqtoc.html.
6. Rao CY, Burge HA, Chang JC. Review of quantitative standards and guidelines for fungi in indoor air. J Air & Waste Manage Assoc 1996;46:899–908.
7. Beck-Sagué CM, Dooley SW, Hutton MD, et al. Hospital outbreak of multidrug-resistant *Mycobacterium tuberculosis* infections: factors in transmission to staff and HIV-infected patients. JAMA 1992;268:1280–6.
8. Dooley SW, Villarino ME, Lawrence M, et al. Nosocomial transmission of tuberculosis in a hospital unit for HIV-infected patients. JAMA 1992;267:2632–4.
9. Sarubbi FA Jr, Kopf HB, Wilson MB, McGinnis MR, Rutala WA. Increased recovery of *Aspergillus flavus* from respiratory specimens during hospital construction. Am Rev Respir Dis 1982;125:33–8.
10. Streifel AJ, Stevens PP, Rhame FS. In-hospital source of airborne *Penicillium* species spores. J Clin Microbiol 1987;25:1–4.
11. Hansen W. The need for an integrated indoor air quality program. In: Hansen W, ed. A guide to managing indoor air quality in health care organizations. Oakbrook Terrace, IL: Joint Commission on Accreditation of Healthcare Organizations, 1997:xiii– xviii.
12. Bartley J. Ventilation. In: Pfeiffer J, ed. APIC text of infection control and epidemiology. Washington, DC: Association for Professionals in Infection Control and Epidemiology, Inc (APIC), 2000:77.1–77.11.
13. Bartley J. Construction and renovation. In: Pfeiffer J, ed. APIC text of infection control and epidemiology. Washington DC: Association for Professionals in Infection Control and Epidemiology, Inc (APIC), 2000:72.1–77.11.
14. Harvey MA. Critical-care–unit bedside design and furnishing: impact on nosocomial infections. Infect Control Hosp Epidemiol 1998;19:597–601.
15. Infection Control Focus Group. Patient care focus groups 1998: assessing organizational readiness for infection control issues related to construction, renovation, and physical plant projects. National Association of Children's Hospitals and Related Institutions.
16. Carter CD, Barr BA. Infection control issues in construction and renovation. Infect Control Hosp Epidemiol 1997;18:587–96.
17. Coronado VG, Beck-Sagué CM, Hutton MD, et al. Transmission of multidrug-resistant *Mycobacterium tuberculosis* among persons with human immunodeficiency virus infection in an urban hospital: epidemiologic and restriction fragment length polymorphism analysis. J Infect Dis 1993;168:1052–5.
18. Coronado VG, Valway S, Finelli L, et al. Nosocomial transmission of multidrug-resistant *Mycobacterium tuberculosis* among intravenous drug users with human immunodeficiency virus infection [Abstract S50]. In: Abstracts of the Third Annual Meeting of the Society for Hospital Epidemiology of America. Chicago, IL. Infect Control Hosp Epidemiol 1993;14:428.
19. Edlin BR, Tokars JI, Grieco MH, et al. An outbreak of multidrug-resistant tuberculosis among hospitalized patients with the acquired immunodeficiency syndrome. N Engl J Med 1992;326:1514–21.
20. Fischl MA, Uttamchandani RB, Daikos GL, et al. An outbreak of tuberculosis caused by multiple-drug–resistant tubercle bacilli among patients with HIV infection. Ann Intern Med 1992;117:177–83.
21. Ikeda RM, Birkhead GS, DeFerdinando Jr GT, et al. Nosocomial tuberculosis: an outbreak of a strain resistant to seven drugs. Infect Control Hosp Epidemiol 1995;16:152–9.
22. Jarvis WR. Nosocomial transmission of multidrug-resistant *Mycobacterium tuberculosis*. Res Microbiol 1992;144:117–22.
23. Jarvis WR. Nosocomial transmission of multidrug-resistant *Mycobacterium tuberculosis*. Am J Infect Control 1995;23:146–51.
24. Jereb JA, Klevens RM, Privett TD, et al. Tuberculosis in health care workers at a hospital with an outbreak of multidrug-resistant *Mycobacterium tuberculosis.* Arch Intern Med 1995;155:854–9.
25. Moran GJ, McCabe F, Morgan MT, Talan DA. Delayed recognition and infection control for tuberculosis patients in the emergency department. Ann Emerg Med 1995;26:283–9.
26. Pearson ML, Jereb JA, Frieden TR, et al. Nosocomial transmission of multidrug-resistant *Mycobacterium tuberculosis*: a risk to patients and health care workers. Ann Intern Med 1992;117:191–6.
27. CDC. Guidelines for prevention of nosocomial pneumonia. MMWR 1997;46(No. RR-1):1–79.
28. Ko G, Burge HA, Muilenberg M, Rudnick S, First M. Survival of mycobacteria on HEPA filter material. J Am Biol Safety Assoc 1998;3:65–78.
29. Gage AA, Dean DC, Schimert G, Minsley N. *Aspergillus* infection after cardiac surgery. Arch Surg 1970;101:384–7.
30. Vargo JA, Ginsberg MM, Mizrahi M. Human infestation by the pigeon mite: a case report. Am J Infect Control 1983;11:24–5.
31. National Air Duct Cleaners Association. NADCA general specifications for the cleaning of commercial HVAC systems. Publication #NAD–06. Washington, DC: National Air Duct Cleaners Association, 2002. Available at http://www.nadca.com/standards/standards.asp.
32. US Environmental Protection Agency, Office of Pesticide Progams. Use of disinfectants and sanitizers in heating, ventilation, air conditioning, and refrigeration systems [Letter]. March 14, 2002. Available at http://www.epa.gov/oppad001/hvac.htm.
33. Rutala WA, Jones SM, Worthington JM, Reist PC, Weber DJ. Efficacy of portable filtration units in reducing aerosolized particles in the size range of *Mycobacterium tuberculosis*. Infect Control Hosp Epidemiol 1995;16:391–8.
34. CDC. Guidelines for preventing the transmission of *Mycobacterium tuberculosis* in health-care facilities. MMWR 1994;43(No. RR-13).
35. American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. Ventilation for acceptable indoor air quality. Atlanta, GA, 1999; ASHRAE Standard 62-1999.
36. Garner JS, Hospital Infection Control Practices Advisory Committee. Guideline for isolation precautions in hospitals. Infect Control Hosp Epidemiol 1996;17:53–80.
37. CDC. Guidelines for preventing opportunistic infections among hematopoietic stem cell transplant recipients. MMWR 2000;49(No. RR-10).
38. Flynn PM, Williams BG, Hethrington SV, Williams BF, Giannini MA, Pearson TA. *Aspergillus terreus* during hospital renovation [Letter]. Infect Control Hosp Epidemiol 1993;14:363–5.
39. Tabbara KF, Al Jabarti A. Hospital construction-associated outbreak of ocular aspergillosis after cataract surgery. Ophthalmology 1998;105:522–6.
40. Rhame FS, Streifel AJ, Kersey JH Jr, McGlave PB. Extrinsic risk factors for pneumonia in the patient at high risk of infection. Am J Med 1984;76:42–52.

41. Wells WF. Aerodynamics of droplet nuclei [Chapter 3]. In: Wells WF. Airborne contagion and air hygiene. Cambridge, MA: Harvard University Press, 1955:13–9.
42. CDC. Epidemiologic notes and reports: nosocomial transmission of multidrug-resistant tuberculosis among HIV-infected persons — Florida and New York, 1988–1991. MMWR 1991;40:585–91.
43. CDC. Outbreak of multidrug-resistant tuberculosis at a hospital — New York City, 1991. MMWR 1993;42:427–34.
44. Gerson SL, Parker P, Jacobs MR, Creger R, Lazarus HM. Aspergillosis due to carpet contamination [Letter]. Infect Control Hosp Epidemiol 1994;15:221–3.
45. Joint Commission on Accreditation of Healthcare Organizations. 2001 hospital accreditation standards. Oakbrook Terrace, IL: JCAHO Press, 2001:193–220.
46. Fridkin SK, Kremer FB, Bland LA, Padhye A, McNeil MM, Jarvis WR. *Acremonium kiliense* endophthalmitis that occurred after cataract extraction in an ambulatory surgical center and was traced to an environmental reservoir. Clin Infect Dis 1996;22:222–7.
47. Streifel AJ. Maintenance and engineering. In: Pfeiffer J, ed. APIC text of infection control and epidemiology. Washington, DC: Association for Professionals in Infection Control and Epidemiology, Inc., 2000:76.1–76.8.
48. Weems JJ Jr, Davis BJ, Tablan OC, Kaufman L, Martone WJ. Construction activity: an independent risk factor for invasive aspergillosis and zygomycosis in patients with hematologic malignancy. Infect Control 1987;8:71–5.
49. Krasinski K, Holzman RS, Hanna B, Greco MA, Graff M, Bhogal M. Nosocomial fungal infection during hospital renovation. Infect Control 1985;6:278–82.
50. Bartley JM. APIC state-of-the-art report: the role of infection control during construction in health care facilities. Am J Infect Control 2000;28:156–69.
51. Walsh TJ, Dixon DM. Nosocomial aspergillosis: environmental microbiology, hospital epidemiology, diagnosis and treatment. Eur J Epidemiol 1989;5:131–42.
52. Johnson MW, Mitch WE, Heller AH, Spector R. The impact of an educational program on gentamicin use in a teaching hospital. Am J Med 1982;73:9–14.
53. Soumerai SB, Salem-Schatz S, Avorn J, Casteris CS, Ross-Degnan D, Popovsky MA. A controlled trial of educational outreach to improve blood transfusion practice. JAMA 1993;270:961–6.
54. Eisenberg JM. An educational program to modify laboratory use by house staff. J Med Educ 1977;52:578–81.
55. Rello J, Quintana E, Ausina V, Puzo V, Puzo C, Net A, Prats G. Risk factors for *Staphylococcus aureus* nosocomial pneumonia in critically ill patients. Am Rev Respir Dis 1990;142:1320–4.
56. McWhinney PHM, Kibbler CC, Hamon MD, et al. Progress in the diagnosis and management of aspergillosis in bone marrow transplantation: 13 years' experience. Clin Infect Dis 1993;17:397–404.
57. Pannuti CS, Gingrich RD, Pfaller MA, Wenzel RP. Nosocomial pneumonia in adult patients undergoing bone marrow transplantation: a 9-year study. J Clin Oncol 1991;9:77–84.
58. Wingard JR, Beals SU, Santos GW, Mertz WG, Saral R. *Aspergillus* infections in bone marrow transplant recipients. Bone Marrow Transplant 1987;2:175–81.
59. Gerson SL, Talbot GH, Hurwitz S, Strom BL, Lusk EJ, Cassileth PA. Prolonged granulocytopenia: the major risk factor for invasive pulmonary aspergillosis in patients with acute leukemia. Ann Intern Med 1984;100:345–51.
60. Lentino JR, Rosenkranz MA, Michaels JA, Kurup VP, Rose HD, Rytel MW. Nosocomial aspergillosis: a retrospective review of airborne disease secondary to road construction and contaminated air conditioners. Am J Epidemiol 1982;116:430–7.
61. Streifel AJ, Lauer JL, Vesley D, Juni B, Rhame FS. *Aspergillus fumigatus* and other thermotolerant fungi generated by hospital building demolition. Appl Environ Microbiol 1983;46:375–8.
62. Thio CL, Smith D, Merz WG, et al. Refinements of environmental assessment during an outbreak investigation of invasive aspergillosis in a leukemia and bone marrow transplant unit. Infect Control Hosp Epidemiol 2000;21:18–23.
63. Mermel LA, Josephson SL, Giorgio CH, Dempsey J, Parenteau S. Association of Legionnaires' disease with construction: contamination of potable water? Infect Control Hosp Epidemiol 1995;16:76–81.
64. Arnow PM, Anderson RL, Mainous PD, Smith EJ. Pulmonary aspergillosis during hospital renovation. Am Rev Respir Dis 1978;118:49–53.
65. Kuehn TH, Gacek B, Yang CH, et al. Identification of contaminants, exposures, effects, and control options for construction/renovation activities (RP-804). ASHRAE Transactions: Research, 1995.
66. Opal SM, Asp AA, Cannady PB Jr, Morse PL, Burton LJ, Hammer PG II. Efficacy of infection control measures during a nosocomial outbreak of disseminated aspergillosis associated with hospital construction. J Infect Dis 1986;153:634–7.
67. Association for Professionals in Infection Control and Epidemiology, Education Committee 1998–99. Infection control tool kit series — construction and renovation. Bartley J, ed. Washington DC: Association for Professionals in Infection Control and Epidemiology, 1999.
68. Ottney TC. Particle management for HVAC systems. ASHRAE J 1993;35:26–34.
69. Finkelstein LE, Mendelson MH. Infection control challenges during hospital renovation. Am J Nursing 1997;97:60–1.
70. Overberger PA, Wadowsky RM, Schaper MM. Evaluation of airborne particulates and fungi during hospital renovation. Am Ind Hyg Assoc J 1995;56:706–12.
71. Streifel AJ, Marshall JW. Parameters for ventilation controlled environments in hospitals. In: Design, construction, and operation of healthy buildings (IAQ/1997). Atlanta, GA: ASHRAE Press, 1998.
72. American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE). The HVAC commissioning process. ASHRAE Guideline 1-1996. Atlanta, GA: ASHRAE Press, 1996.
73. Morey R, Williams C. Porous insulation in buildings: a potential source of microorganisms. In: Proceedings of Indoor Air '90, 5th International Conference. Toronto, Canada: International Society of Indoor Air Quality and Climate, 1990.
74. Aisner J, Murillo J, Schimpff SC, Steere AC. Invasive aspergillosis in acute leukemia: correlation with nose cultures and antibiotic use. Ann Intern Med 1979;90:4–9.
75. McCarty JM, Flam MS, Pullen G, Jones R, Kassel SH. Outbreak of primary cutaneous aspergillosis related to intravenous arm boards. J Pediatr 1986;108(Pt.1):721–4.
76. Klimowski LL, Rotstein C, Cummings KM. Incidence of nosocomial aspergillosis in patients with leukemia over a twenty-year period. Infect Control Hosp Epidemiol 1989;10:299–305.
77. Pfundstein J. *Aspergillus* infection among solid organ transplant recipients: a case study. J Transpl Coord 1997;7:187–9.

78. Rhame FS, Streifel A, Stevens P, et al. Endemic *Aspergillus* airborne spore levels are a major risk factor for aspergillosis in bone marrow transplant (BMT) patients [Abstract]. In: Program and abstracts of the 25th Interscience Conference on Antimicrobial Agents and Chemotherapy. Minneapolis, MN: American Society for Microbiology, 1985.
79. Walmsley S, Devi S, King S, Schneider R, Richardson S, Ford-Jones L. Invasive *Aspergillus* infections in a pediatric hospital: a ten-year review. Pediatr Infect Dis J 1993;12:673–82.
80. Kyriakides GK, Zinneman HH, Hall WH, et al. Immunologic monitoring and aspergillosis in renal transplant patients. Am J Surg 1976;131:246–52.
81. Abzug MJ, Gardner S, Glode MP, Cymanski M, Roe MH, Odom LF. Heliport-associated nosocomial mucormycoses [Letter]. Infect Control Hosp Epidemiol 1992;13:325–6.
82. Sherertz RJ, Belani A, Kramer BS, et al. Impact of air filtration on nosocomial *Aspergillus* infections: unique risk of bone marrow transplant recipients. Am J Med 1987;83:709–18.
83. Aisner J, Schimpff SC, Bennett JE, Young VM, Wiernik PH. *Aspergillus* infections in cancer patients: association with fireproofing materials in a new hospital. JAMA 1976;235:411–2.
84. Fox BC, Chamberlin L, Kulich P, Rae EJ, Webster LR. Heavy contamination of operating room air by *Penicillium* species: identification of the source and attempts at decontamination. Am J Infect Control 1990;18:300–6.
85. Barnes RA, Rogers TR. Control of an outbreak of nosocomial aspergillosis by laminar air-flow isolation. J Hosp Infect 1989;14:89–94.
86. Leenders A, VanBelkum A, Janssen S, et al. Molecular epidemiology of apparent outbreaks of invasive aspergillosis in a hematology ward. J Clin Microbiol 1996;34:345–51.
87. Yeager CC. Copper and zinc preservatives [Chapter 21]. In: Block SS, ed. Disinfection, sterilization, and preservation. 4th ed. Philadelphia, PA: Lea and Febiger, 1991.
88. Allo MD, Miller J, Townsend T, Tan C. Primary cutaneous aspergillosis associated with Hickman intravenous catheters. N Engl J Med 1987;317:1105–8.
89. Schleupner CJ, Hamilton JR. A pseudoepidemic of pulmonary fungal infections related to fiberoptic bronchoscopy. Infect Control 1980;1:38–42.
90. Denning DW, Clemons KV, Hanson LH, Stevens DA. Restriction endonuclease analysis of total cellular DNA of *Aspergillus fumigatus* isolates of geographically and epidemiologically diverse origin. J Infect Dis 1990;162:1151–8.
91. James MJ, Lasker BA, McNeil MM, Shelton M, Warnock DW, Reiss E. Use of a repetitive DNA probe to type clinical and environmental isolates of *Aspergillus flavus* from a cluster of cutaneous infections in a neonatal intensive care unit. J Clin Microbiol 2000;38:3612–8.
92. Skladny H, Buchheidt D, Baust C, et al. Specific detection of *Aspergillus* species in blood and bronchoalveolar lavage samples of immunocompromised patients by two-step PCR. J Clin Microbiol 1999;37:3865–71.
93. Symoens F, Bouchara JP, Heinemann S, Nolard N. Molecular typing of *Aspergillus terreus* isolates by random amplification of polymorphic DNA. J Hosp Infect 2000;44:273–80.
94. Diaz-Guerra TM, Mellado E, Cuenca-Estrella M, Gaztelurrutia L, Navarro JI, Tudela JL. Genetic similarity among one *Aspergillus flavus* strain isolated from a patient who underwent heart surgery and two environmental strains obtained from the operating room. J Clin Microbiol 2000;38:2419–22.
95. Siegler L, Kennedy MJ. *Aspergillus, Fusarium*, and other opportunistic moniliaceous fungi. In: Murray PR, Baron EJ, Pfaller MA, Tenover FC, Yolken RH, eds. Manual of clinical microbiology. 7th ed. Washington, DC: American Society for Microbiology Press. 1999:1212–41.
96. Breton P, Germaud P, Morin O, Audouin AF, Milpied N, Harousseau JL. Unusual pulmonary mycoses in patients with hematologic disease [French]. Rev Pneumol Clin 1998;54:253–7.
97. Guarro J, Nucci M, Akiti T, Gené J, Barreiro MD, Gonçalves RT. Fungemia due to *Fusarium sacchari* in an immunosuppressed patient. J Clin Microbiol 2000;38:419–21.
98. Burton JR, Zachery JB, Bessin R, et al. Aspergillosis in four renal transplant patients: diagnosis and effective treatment with amphotericin B. Ann Intern Med 1972;77:383–8.
99. Buckner CD, Clift RA, Sanders JE, et al. Protective environment for marrow transplant recipients: a prospective study. Ann Intern Med 1978;89:893–901.
100. Murray WA, Streifel AJ, O'Dea TJ, Rhame FS. Ventilation for protection of immune compromised patients. ASHRAE Transactions 1988;94:1185–91.
101. Streifel AJ, Vesley D, Rhame FS, Murray B. Control of airborne fungal spores in a university hospital. Environment International 1989;15: 221–7.
102. Rhame FS. Endemic nosocomial filamentous fungal disease: a proposed structure for conceptualizing and studying the environmental hazard. Infect Control 1986;7(suppl 2):124–5.
103. American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc. 1999 ASHRAE handbook: heating, ventilating, and air-conditioning applications. Health care facilities [Chapter 7]. Atlanta GA: American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc., 1999.
104. Mahoney DH Jr, Steuber CP, Starling KA, Barrett FF, Goldberg J, Fernbach DJ. An outbreak of aspergillosis in children with acute leukemia. J Pediatr 1979;95:70–2.
105. Ehrenkranz NJ, Kicklighter JL. Tuberculosis outbreak in a general hospital: evidence for airborne spread of infection. Ann Intern Med 1972;77:377–82.
106. Calder RA, Duclos P, Wilder MH, Pryor VL, Scheel, WJ. *Mycobacterium tuberculosis* transmission in a health clinic. Bull Int Union Tuberc Lung Dis 1991;66:103–6.
107. Jereb JA, Burwen DR, Dooley SW, et al. Nosocomial outbreak of tuberculosis in a renal transplant unit: application of a new technique for restriction fragment length polymorphism analysis of *Mycobacterium tuberculosis* isolates. J Infect Dis 1993;168:1219–24.
108. Monath TP. Yellow fever: Victor, Victoria? Conqueror, conquest? Epidemics and research in the last forty years and prospects for the future. Am J Trop Med Hyg 1991;45:1–43.
109. CDC. Update: Management of patients with suspected viral hemorrhagic fever — United States. MMWR 1995;44:475–9.
110. Weber DJ, Rutala WA. Risks and prevention of nosocomial transmission of rare zoonotic diseases. Clin Infect Dis 2001;32:446–56.
111. Gerberding JL. Nosocomial transmission of opportunistic infections. Infect Control Hosp Epidemiol 1998;19:574–7.
112. Vargas SL, Ponce CA, Gigliotti F, et al. Transmission of *Pneumocystis carinii* DNA from a patient with *P. carinii* pneumonia to immunocompetent contact health care workers. J Clin Microbiol 2000;38:1536–8.
113. Walzer PD. *Pneumocystis carinii* [Chapter 260]. In: Mandell GL, Bennett JE, Dolin R., eds. Principles and practice of infectious diseases. 5th ed. Philadelphia, PA: Churchill Livingstone, 2000:2781–95.

114. Mangram AJ, Horan TC, Pearson ML, Silver LC, Jarvis WR, Hospital Infection Control Practices Advisory Committee. Guideline for prevention of surgical site infection, 1999. Infect Control Hosp Epidemiol 1999;20:247–80.
115. Lidwell OM. Clean air at operation and subsequent sepsis in the joint. Clin Orthop 1986;211:91–102.
116. Nichols RL. The operating room [Chapter 22]. In: Bennett JV, Brachman PS, eds. Hospital infections. 3rd ed. Boston, MA: Little, Brown and Company, 1992:461–73.
117. Clark RP, Reed PJ, Seal DV, Stephenson ML. Ventilation conditions and air-borne bacteria and particles in operating theatres: proposed safe economies. J Hyg (Lond) 1985;95:325–35.
118. Babb JR, Lynam P, Ayliffe GAJ. Risk of airborne transmission in an operating theater containing four ultraclean air units. J Hosp Infect 1995;31:159–68.
119. Laufman H. The operating room [Chapter 20]. In: Bennett JV, Brachman PS, eds. Hospital Infections. 2nd ed. Boston, MA: Little, Brown and Company,1986:315–23.
120. Ad Hoc Committee of the Committee on Trauma, Division of Medical Sciences, National Academy of Sciences — National Research Council. Postoperative wound infections: the influence of ultraviolet irradiation of the operating room and of various other factors. Ann Surg 1964;160(suppl):1–192.
121. Charnley J. A clean-air operating enclosure. Br J Surg 1964;51:202–5.
122. Lidwell OM, Lowbury EJ, Whyte W, Blowers R, Stanley SJ, Lowe D. Effect of ultraclean air in operating rooms on deep sepsis in the joint after total hip or knee replacement: a randomised study. Br Med J 1982;285:10–4.
123. Hill C, Flamant R, Mazas F, Evrard J. Prophylactic cefazolin versus placebo in total hip replacement: report of a multicentre double-blind randomised trial. Lancet 1981;1:795–6.
124. Ha'eri GB, Wiley AM. Total hip replacement in a laminar flow environment with special reference to deep infections. Clin Orthop 1980;148:163–8.
125. Collins DK, Steinhaus K. Total hip replacement without deep infection in a standard operating room. J Bone Joint Surg Am 1976;58:446–50.
126. Taylor GJ, Bannister GC, Leeming JP. Wound disinfection with ultraviolet radiation. J Hosp Infect 1995;30:85–93.
127. Ayliffe GA. Role of the environment of the operating suite in surgical wound infection. Rev Infect Dis 1991;13(suppl 10):S800–4.
128. Choux M, Genitori L, Lang D, Lena G. Shunt implantation: reducing the incidence of shunt infection. J Neurosurg 1992;77:875–80.
129. Occupational Safety and Health Administration. 29 CFR 1910.139. Respiratory Protection. Federal Register 1998;63:1152–300.
130. Langevin PB, Rand KH, Layton AJ. The potential for dissemination of *Mycobacterium tuberculosis* through the anesthesia breathing circuit. Chest 1999;115:1107–14.
131. Occupational Safety and Health Administration. 29 CFR 1910. Occupational exposure to tuberculosis proposed rule. Federal Register 1997;62:54159–209.
132. Aranha-Creado H, Prince D, Greene K, Brandwein H. Removal of *Mycobacterium* species by breathing circuit filters. Infect Control Hosp Epidemiol 1997;18:252–4.
133. Burroughs HE. Sick building syndrome: fact, fiction, or facility? In: Hansen W., ed. A guide to managing indoor air quality in health care organizations. Oakbrook Terrace, IL: Joint Commission on Accreditation of Health Care Organizations, 1997:3–13.
134. Anderson K, Morris G, Kennedy H, et al. Aspergillosis in immunocompromised paediatric patients: associations with building hygiene, design, and indoor air. Thorax 1996;51:256–61.
135. National Institute for Occupational Safety and Health. Control of smoke from laser/electric surgical procedures, 1996; DHHS publication no. (NIOSH) 96–128. Available at http://www.cdc.gov/niosh/hc11.html.
136. Association of Perioperative Registered Nurses. Recommended practices for laser safety in practice settings. AORN J 1998;67:263–4, 267–9.
137. Hughes PS, Hughes AP. Absence of human papillomavirus DNA in the plume of erbium: YAG laser-treated warts. J Am Acad Dermatol 1998;38:426–8.
138. Capizzi PJ, Clay RP, Battey MJ. Microbiologic activity in laser resurfacing plume and debris. Lasers Surg Med 1998;23:172–4.
139. Emergency Care Research Institute (ECRI). Surgical smoke evacuation systems. Health Devices 1997;26:132–72.
140. ECRI. Update evaluation: surgical smoke evacuation systems. Health Devices 1999;28:333–62.
141. ECRI. Stationary surgical smoke evacuation systems. Health Devices 2001;30:73–86.
142. Villarino ME, Stevens LE, Schable B, et al. Risk factors for epidemic *Xanthomonas maltophilia* infection/colonization in intensive care unit patients. Infect Control Hosp Epidemiol 1992;13:201–6.
143. Seifert H, Strate A, Pulverer G. Nosocomial bacteremia due to *Acinetobacter baumannii*: clinical features, epidemiology, and predictors of mortality. Medicine (Baltimore) 1995;74:340–9.
144. Yu VL. *Serratia marcescens*: historical perspective and clinical review. N Engl J Med 1979;300:887–93.
145. Go ES, Urban C, Burns J, et al. Clinical and molecular epidemiology of *Acinetobacter* infections sensitive only to polymyxin B and sulbactam. Lancet 1994;344:1329–32.
146. Boyce JM, Pittet D. Guideline for hand hygiene in health-care settings: recommendations of the Healthcare Infection Control Practices Advisory Committee and the HICPAC/SHEA/APIC/IDSA Hand Hygiene Task Force. Infect Control Hosp Epidemiol 2002;23 (suppl):S3–40.
147. Burdge DR, Nakielna EM, Noble MA. Case-control and vector studies of nosocomial acquisition of *Pseudomonas cepacia* in adult patients with cystic fibrosis. Infect Control Hosp Epidemiol 1993;14:127–30.
148. Cox R, deBorja K, Bach MC. A pseudo-outbreak of *Mycobacterium chelonae* infections related to bronchoscopy. Infect Control Hosp Epidemiol 1997;18:136–7.
149. Hoy J, Rolston K, Hopfer RL. Pseudoepidemic of *Mycobacterium fortuitum* in bone marrow cultures. Am J Infect Control 1987;15:268–71.
150. Stine TM, Harris AA, Levin S, Rivera N, Kaplan, RL. A pseudoepidemic due to atypical mycobacteria in a hospital water supply. JAMA 1987;258:809–11.
151. Bennett SN, Peterson DE, Johnson DR, Hall WN, Robinson-Dunn B, Dietrich S. Bronchoscopy-associated *Mycobacterium xenopi* pseudoinfections. Am J Respir Crit Care Med 1994;150:245–50.
152. Hlady WG, Mullen RC, Mintz CS, Shelton BG, Hopkins RS, Daikos GL. Outbreak of Legionnaire's disease linked to a decorative fountain by molecular epidemiology. Am J Epidemiol 1993;138:555–62.
153. American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc.. ASHRAE guideline 12–2000: minimizing the risk of legionellosis associated with building water systems. Atlanta, GA: ASHRAE, Inc., 2000:1–6.

154. Snyder MB, Siwicki M, Wireman J, et al. Reduction of *Legionella pneumophila* through heat flushing followed by continuous supplemental chlorination of hospital hot water. J Infect Dis 1990;162:127–32.
155. Ezzeddine H, Van Ossel C, Delmée M, Wauters G. *Legionella* spp. in a hospital hot water system: effect of control measures. J Hosp Infect 1989;13:121–31.
156. Joint Commission on Accreditation of Healthcare Organizations. Comprehensive accreditation manual for hospitals: the official handbook. Oakbrook Terrace, IL: JCAHO Press, 2000.
157. Juranek DD, Addiss DG, Bartlett ME, et al. Crytosporidiosis and public health: workshop report. Journal of the American Water Works Association 1995;87:69–80.
158. Tokars JI, Miller ER, Alter MJ, Arduino MJ. National surveillance of dialysis-associated diseases in the United States, 1997. Semin Dial 2000;13:75-85.
159. Vujanovic V, Smoragiewicz W, Krzysztyniak K. Airborne fungal ecological niche determination as one of the possibilities for indirect mycotoxin risk assessment in indoor air. Environ Toxicol 2001;16:1–8.
160. Vesper S, Dearborn DG, Yike I, et al. Evaluation of *Stachybotrys chartarum* in the house of an infant with pulmonary hemorrhage: quantitative assessment before, during, and after remediation. J Urban Health 2000;77:68–85.
161. Best M, Yu VL, Stout J, Goetz A, Muder RR, Taylor F. Legionellaceae in the hospital water-supply: epidemiologic link with disease and evaluation of a method for control of nosocomial Legionnaires' disease and Pittsburgh pneumonia. Lancet 1983;2:307–10.
162. Meenhorst PL, Reingold AL, Groothuis DG, et al. Water-related nosocomial pneumonia caused by *Legionella pneumophila* serogroups 1 and 10. J Infect Dis 1985;152:356–64.
163. Johnston JM, Latham RH, Meier FA, et al. Nosocomial outbreak of Legionnaires' disease: molecular epidemiology and disease control measures. Infect Control 1987;8:53–8.
164. Muraca PW, Yu VL, Goetz A. Disinfection of water distribution systems for *Legionella*: a review of application procedures and methodologies. Infect Control Hosp Epidemiol 1990;11:79–88.
165. Johnson JT, Yu VL, Best MG, et al. Nosocomial legionellosis in surgical patients with head and neck cancer: implications for epidemiological reservoir and mode of transmission. Lancet 1985;2:298–300.
166. Marrie TJ, MacDonald S, Clarke K, Haldane D. Nosocomial legionnaires' disease: lessons from a four-year prospective study. Am J Infect Control 1991;19:79–85.
167. Marrie TJ, Haldane D, Bezanson G, Peppard R. Each water outlet is a unique ecological niche for Legionella pneumophila. Epidemiol Infect 1992;108:261–70.
168. Department of Health and Social Security and the Welsh Office. The control of *Legionellae* in health care premises: a code of practice. London: Her Majesty's Stationery Office, 1991.
169. Helms CM, Massanari RM, Wenzel RP, et al. Legionnaires' disease associated with a hospital water system: a five-year progress report on continuous hyperchlorination. JAMA 1988;259:2423–7.
170. Edelstein PH, Whittaker RE, Kreiling RL, Howell, CL. Efficacy of ozone in eradication of *Legionella pneumophila* from hospital plumbing fixtures. Appl Environ Microbiol 1982;44:1330–4.
171. Muraca P, Stout JE, Yu VL. Comparative assessment of chlorine, heat, ozone, and UV light for killing *Legionella pneumophila* within a model plumbing system. Appl Environ Microbiol 1987;53:447–53.
172. Domingue EL, Tyndall RL, Mayberry WR, Pancorbo OC. Effects of three oxidizing biocides on *Legionella pneumophila* serogroup 1. Appl Environ Microbiol 1988;54:741–7.
173. Landeen LK, Yahya MT, Gerba CP. Efficacy of copper and silver ions and reduced levels of free chlorine in inactivation of *Legionella pneumophila.* Appl Environ Microbiol 1989;55:3045–50.
174. Matulonis U, Rosenfeld CS, Shadduck RK. Prevention of *Legionella* infections in bone marrow transplant unit: multifaceted approach to decontamination of a water system. Infect Control Hosp Epidemiol 1993;14:571–5.
175. Liu Z, Stout JE, Tedesco L, et al. Controlled evaluation of copper-silver ionization in eradicating *Legionella pneumophila* from a hospital water distribution system. J Infect Dis 1994;169:919–22.
176. Margolin AB. Control of microorganisms in source water and drinking water [Chapter 20]. In: Hurst CJ, Knudsen GR, McInerney MJ, Stetzenback LD, Walter MV, eds. Manual of environmental microbiology. Washington, DC: American Society for Microbiology Press, 1997:195–202.
177. Freije MR. *Legionella* control in health care facilities: a guide for minimizing risk. Indianapolis, In: HC Information Resources, Inc., 1996:65–75.
178. Lin YE, Vidic RD, Stout JE, Yu VL. *Legionella* in water distribution systems: regular culturing of distribution system samples is the key to successful disinfection. Journal of the American Water Works Association 1998;90:112–21.
179. Biurrun A, Caballero L, Pelaz C, León E, Gago A. Treatment of a *Legionella pneumophila*- colonized water distribution system using copper-silver ionization and continuous chlorination. Infect Control Hosp Epidemiol 1999;20:426–8.
180. Goetz A, Yu VL. Copper-silver ionization: Cautious optimism for *Legionella* disinfection and implications for environmental culturing. Am J Infect Control 1997;25:449–451.
181. Stout JE, Lin EY, Goetz AM, Muder RR. Controlling *Legionella* in hospital water systems: experience with the superheat-and-flush method and copper-silver ionization. Infect Control Hosp Epidemiol 1998;19:911–4.
182. Walker JT, Mackerness CW, Mallon D, Makin T, Williets T, Keevil CW. Control of *Legionella pneumophila* in a hospital water system by chlorine dioxide. J Ind Microbiol 1995;15:384–90.
183. Hambidge A. Reviewing efficacy of alternative water treatment techniques. Health Estate Journal 2001;55:23–5.
184. Rohr U, Senger M, Selenka F, Turley R, Wilhelm M. Four years of experience with silver-copper ionization for control of *Legionella* in a German university hospital hot water plumbing system. Clin Infect Dis 1999;29:1507–11.
185. Cunliffe DA. Inactivation of *Legionella pneumophila* by monochloramine. J Appl Bacteriol 1990;68:453–9.
186. Kirmeyer GJ, Foust GW, Pierson GL, Simmler JJ, LeChevalier MW. Optimizing chloramine treatment. Denver, CO; American Water Works Research Foundation, 1993.
187. Kool JL, Carpenter JC, Fields BS. Effect of monochloramine disinfection of municipal drinking water on risk of nosocomial Legionnaires' disease. Lancet 1999;353:272–7.
188. Kool JL, Bergmire-Sweat D, Butler JC, et al. Hospital characteristics associated with colonization of water systems by *Legionella* and risk of nosocomial Legionnaires' disease: a cohort study of 15 hospitals. Infect Control Hosp Epidemiol 1999;20:798–805.
189. Kool JL, Fiore AE, Kioski CM, et al. More than 10 years of unrecognized nosocomial transmission of Legionnaires' disease among transplant patients. Infect Control Hosp Epidemiol 1998;19:898–904.

190. Le Saux NM, Sekla L, McLeod J, et al. Epidemic of nosocomial Legionnaires' disease in renal transplant recipients: a case-control and environmental study. CMAJ 1989;140:1047–53.
191. Kugler JW, Armitage JO, Helms CM, et al. Nosocomial Legionnaires' disease: occurrence in recipients of bone marrow transplants. Am J Med 1983;74:281–8.
192. Marston BJ, Lipman HB, Breiman RF. Surveillance for Legionnaires' disease: risk factors for morbidity and mortality. Arch Intern Med 1994;154:2417–22.
193. Haley CE, Cohen ML, Halter J, Meyer RD. Nosocomial Legionnaires' disease: a continuing common-source epidemic at Wadsworth Medical Center. Ann Intern Med 1979;90:583–6.
194. Jimènez ML, Aspa J, Padilla B, et al. Fiberoptic bronchoscopic diagnosis of pulmonary disease in 151 HIV-infected patients with pneumonitis. Eur J Clin Microbiol Infect Dis 1991; 10:491–7.
195. Bock BV, Kirby BD, Edelstein PH, et al. Legionnaires' disease in renal-transplant recipients. Lancet 1978;1:410–3.
196. Kirby BD, Snyder KM, Meyer RD, Finegold SM. Legionnaires' disease: report of sixty-five nosocomially acquired cases and review of the literature. Medicine (Baltimore) 1980;59:188–205.
197. Brady MT. Nosocomial legionnaires disease in a children's hospital. J Pediatr 1989;115:46–50.
198. Muder RR, Yu VL, McClure JK, Kroboth FJ, Kominos SD, Lumish RM. Nosocomial Legionnaires' disease uncovered in a prospective pneumonia study: implications for underdiagnosis. JAMA 1983;249:3184–8.
199. Garbe PL, Davis BJ, Weisfeld JS, et al. Nosocomial Legionnaires' disease: epidemiologic demonstration of cooling towers as a source. JAMA 1985;254:521–4.
200. Hanrahan JP, Morse DL, Scharf VB, et al. A community hospital outbreak of legionellosis: transmission by potable hot water. Am J Epidemiol 1987;125:639–49.
201. Arnow PM, Chou T, Weil D, Shapiro EN, Kretzschmar C. Nosocomial Legionnaires' disease caused by aerosolized tap water from respiratory devices. J Infect Dis 1982;146:460–7.
202. Mastro TD, Fields BS, Breiman RF, Campbell J, Plikaytis BD, Spika JS. Nosocomial Legionnaires' disease and use of medication nebulizers. J Infect Dis 1991;163:667–70.
203. Dondero TJ Jr, Rendtorff RC, Mallison GF, et al. An outbreak of Legionnaires' disease associated with a contaminated air-conditioning cooling tower. N Engl J Med 1980;302:365–70.
204. O'Mahony MC, Stanwell-Smith RE, Tillett HE, et al. The Stafford outbreak of Legionnaires' disease. Epidemiol Infect 1990;104:361–80.
205. Breiman RF, Fields BS, Sanden G, Volmer L, Meier A, Spika JS. Association of shower use with Legionnaires' disease: possible role of amoebae. JAMA 1990;263:2924–6.
206. Breiman RF, VanLoock FL, Sion JP, et al. Association of "sink bathing" and Legionnaires' disease [Abstract]. In: Program and abstracts of the 91st General Meeting of the American Society for Microbiology. Dallas, TX: American Society for Microbiology, 1991.
207. Struelens MJ, Maes N, Rost F, et al. Genotypic and phenotypic methods for the investigation of a nosocomial *Legionella pneumophila* outbreak and efficacy of control measures. J Infect Dis 1992;166:22–30.
208. Barbaree JM, Gorman GW, Martin WT, Fields BS, Morrill WE. Protocol for sampling environmental sites for Legionellae. Appl Environ Microbiol 1987;53:1454–8.
209. Schoonmaker D, Heimberger T, Birkhead G. Comparison of ribotyping and restriction enzyme analysis using pulsed-field gel electrophoresis for distinguishing *Legionella pneumophila* isolates obtained during a nosocomial outbreak. J Clin Microbiol 1992;30:1491–8.
210. Knirsch CA, Jakob K, Schoonmaker D, et al. An outbreak of *Legionella micdadei* pneumonia in transplant patients: evaluation, molecular epidemiology, and control. Am J Med 2000;108:290–5.
211. CDC. Sustained transmission of nosocomial Legionnaires Disease — Arizona and Ohio. MMWR 1997;46:416–21.
212. Alary M, Joly JR. Factors contributing to the contamination of hospital water distribution systems by Legionellae. J Infect Dis 1992;165:565–9.
213. Yu VL, Beam TR Jr, Lumish RM, et al. Routine culturing for *Legionella* in the hospital environment may be a good idea: A three-hospital prospective study. Am J Med Sci 1987;294:97–9.
214. Tobin JO, Swann RA, Bartlett CL. Isolation of *Legionella pneumophila* from water systems: Methods and preliminary results. Br Med J 1981;282:515–7.
215. Chow JW, Yu VL. Legionella: a major opportunistic pathogen in transplant recipients. Semin Respir Infect 1998;13:132–9.
216. Mandel AS, Sprauer MA, Sniadack DH, Ostroff SM. State regulation of hospital water temperature. Infect Control Hosp Epidemiol 1993;14:642–5.
217. Hirani NA, Macfarlane JT. Impact of management guidelines on the outcome of severe community acquired pneumonia. Thorax 1997;52:17–21.
218. Patterson WJ, Hay J, Seal DV, McLuckie JC. Colonization of transplant unit water supplies with Legionella and protozoa: precautions required to reduce the risk of legionellosis. J Hosp Infect 1997;37:7–17.
219. Marrie TJ, Haldane D, MacDonald S, et al. Control of endemic nosocomial Legionnaires' disease by using sterile potable water for high risk patients. Epidemiol Infect 1991;107:591–605.
220. Zuravleff JJ, Yu VL, Shonnard JW, Rihs JD, Best M. *Legionella pneumophila* contamination of a hospital humidifier: demonstration of aerosol transmission and subsequent subclinical infection in exposed guinea pigs. Am Rev Respir Dis 1983;128:657–61.
221. World Health Organization, Regional Office for Europe. Environmental aspects of the control of legionellosis [German]. Schriftenr Ver Wasser Boden Lufthyg 1993;91:249–52.
222. Bhopal RS, Barr G. Maintenance of cooling towers following two outbreaks of Legionnaires' disease in a city. Epidemiol Infect 1990;104:29–38.
223. World Health Organization. Epidemiology, prevention, and control of legionellosis: memorandum from a WHO meeting. Bull World Health Organ 1990;68:155–64.
224. Bolan G, Reingold AL, Carson LA, et al. Infections with *Mycobacterium chelonae* in patients receiving dialysis and using processed hemodialyzers. J Infect Dis 1985;152:1013–9.
225. Lowry PW, Beck-Saguè CM, Bland LA, et al. *Mycobacterium chelonae* infection among patients receiving high-flux dialysis in a hemodialysis clinic in California. J Infect Dis 1990;161:85–90.
226. Favero MS, Petersen NJ, Boyer KM, Carson LA, Bond WW. Microbial contamination of renal dialysis systems and associated health risks. Trans Am Soc Artif Intern Organs 1974;20:175–83.
227. Favero MS, Petersen NJ, Carson LA, Bond WW, Hindman SH. Gram-negative water bacteria in hemodialysis systems. Health Lab Sci 1975;12:321–34.
228. Favero MS, Petersen NJ. Microbiologic guidelines for hemodialysis systems. Dialysis Transplant 1997;6:34–6.

229. Association for the Advancement of Medical Instrumentation and American National Standards Institute. Hemodialysis systems. ANSI/AAMI RD5-1992. Arlington, VA: 1993.
230. Association for the Advancement of Medical Instrumentation, American National Standards Institute. Reuse of hemodialyzers. ANSI/AAMI RD47-1993. Arlington, VA: 1993.
231. Petersen NJ, Boyer KM, Carson LA, Favero MS. Pyrogenic reactions from inadequate disinfection of a dialysis fluid distribution system. Dialysis Transpl 1978;7:52–7.
232. Dawids SG, Vejlsgaard R. Bacteriological and clinical evaluation of different dialysate delivery systems. Acta Med Scand 1976;199:151–5.
233. Kidd EE. Bacterial contamination of dialyzing fluid of artificial kidney. Br Med J 1964;1:880–2.
234. Klein E, Pass T, Harding GB, Wright R, Million C. Microbial and endotoxin contamination in water and dialysate in the central United States. Artif Organs 1990;14:85–94.
235. Man NK, Degremont A, Darbord JC, Collet M, Vaillant P. Evidence of bacterial biofilm in tubing from hydraulic pathway of hemodialysis system. Artif Organs 1998;22:596–600.
236. Association for the Advancement of Medical Instrumentation. Water treatment equipment for hemodialysis applications. ANSI/AAMI RD62–2001. American National Standards Institute, Inc. Arlington, VA: 2001.
237. Bland LA. Microbiological and endotoxin assays of hemodialysis fluids. Adv Renal Replace Ther 1995;2:70–9.
238. Arduino MJ, Bland LA, Aguero SM, Carson LA, Ridgeway M, Favero MS. Comparison of microbiologic assay methods for hemodialysis fluids. J Clin Microbiol 1991;29:592–4.
239. Bland LA, Ridgeway MR, Aguero SM, Carson LA, Favero MS. Potential bacteriologic and endotoxin hazards associated with liquid bicarbonate concentrate. ASAIO Trans 1987;33:542–5.
240. Raij L, Shapiro FL, Michael AF. Endotoxemia in febrile reactions during hemodialysis. Kidney Int 1973;4:57–60.
241. Bommer J, Becker KP, Urbaschek R. Potential transfer of endotoxin across high-flux polysulfone membranes. J Am Soc Nephrol 1996;7:883–8.
242. Arduino MJ, Favero MS. Microbiologic aspects of hemodialysis. Arlington, VA: Association for the Advancement of Medical Instrumentation, 1998. AAMI monograph WQD–1998.
243. Koepke GH, Christopher RP. Contamination of whirlpool baths during treatment of infected wounds. Arch Phys Med Rehabil 1965;46:261–3.
244. CDC. Epidemiologic notes and reports: outbreak of viral gastroenteritis — Pennsylvania and Delaware. MMWR 1987;36:709–11.
245. Crow HE, Corpe RF, Smith CE. Is serious pulmonary disease caused by nonphotochromogenic ("atypical") acid-fast mycobacteria communicable? Dis Chest 1961;39:372–81.
246. Stout JE, Yu VL, Muraca P. Isolation of *Legionella pneumophila* from the cold water of hospital ice machines: implications for origin and transmission of the organism. Infect Control 1985;6:141–6.
247. Manangan LP, Anderson RL, Arduino MJ, Bond WW. Sanitary care and maintenance of ice-storage chests and ice-making machines in health care facilities. Am J Infect Control 1998;26:111–2.
248. Cannon RO, Poliner JR, Hirschhorn RB, et al. A multistate outbreak of Norwalk virus gastroenteritis associated with consumption of commercial ice. J Infect Dis 1991;164:860–3.
249. Khan AS, Moe CL, Glass RI, et al. Norwalk virus-associated gastroenteritis traced to ice consumption aboard a cruise ship in Hawaii: comparison and application of molecular method-based assays. J Clin Microbiol 1994;32:318–22.
250. Schmidt OW, Cooney MK, Foy HM. Adeno-associated virus in adenovirus type 3 conjunctivitis. Infect Immun 1975;11:1362–70.
251. McCandlish R, Renfrew M. Immersion in water during labor and birth: the need for evaluation. Birth 1993;20:79–85.
252. White CG. Chemistry of chlorination [Chapter 4]. In: Handbook of Chlorination and Alternative Disinfectants. 3rd ed. New York, NY: Van Nostrand Reinhold, 1992:184–249.
253. Muscarella LF. Automatic flexible endoscope reprocessors. Gastrointest Endosc Clin N Am 2000;10:245–57.
254. Muscarella LF. Anticipated reliability of liquid chemical sterilants [Letter]. Am J Infect Control 1998;26:155–6.
255. Muscarella LF. Déjà vu . . . all over again? The importance of instrument drying [Letter]. Infect Control Hosp Epidemiol 2000;21:628–9.
256. Gubler JG, Salfinger M, von Graevenitz A. Pseudoepidemic of nontuberculous mycobacteria due to a contaminated bronchoscope cleaning machine: report of an outbreak and review of the literature. Chest 1992;101:1245–9.
257. Fraser VJ, Jones M, Murray PR, Medoff G, Zhang Y, Wallace RJ Jr. Contamination of flexible fiberoptic bronchoscopes with *Mycobacterium chelonae* linked to an automated bronchoscope disinfection machine. Am Rev Respir Dis 1992;145:853–5.
258. Muscarella LF. Application of environmental sampling to flexible endoscope reprocessing: the importance of monitoring the rinse water. Infect Control Hosp Epidemiol 2002; 23:285–9.
259. Cooke RP, Whymant-Morris A, Umasankar RS, Goddard SV. Bacteria-free water for automatic washer-disinfectors: an impossible dream? J Hosp Infect 1998;39:63–5.
260. Allen JJ, Allen MO, Olsen MM, et al. *Pseudomonas* infection of the biliary system resulting from the use of a contaminated endoscope. Gastroenterology 1987;92:759–63.
261. Michele TM, Cronin WA, Graham NM, et al. Transmission of *Mycobacterium tuberculosis* by a fiberoptic bronchoscope: identification by DNA fingerprinting. JAMA 1997;278:1093–95.
262. US Food and Drug Administration, CDC. Public health advisory: infections from endoscopes inadequately reprocessed by an automated endoscope reprocessing system. September 10, 1999. Available at http://www.fda.gov/cdrh/safety/endoreprocess.pdf.
263. Alvarado CJ, Reichelderfer M. APIC guideline for infection prevention and control in flexible endoscopy. Am J Infect Control 2000;28:138–55.
264. CDC. Statement from CDC regarding biofilm and dental unit water quality. Atlanta GA: US Department of Health and Human Services, Public Health Service, CDC, 1999.
265. CDC. Recommended infection-control practices for dentistry, 1993. MMWR 1993;42 (No. RR-3):1–12.
266. Office of Safety and Asepsis Procedures Research Foundation. Dental unit waterlines. OSAP position paper. Annapolis, MD: 2000. Available at http://www.osap.org/issues/pages/water/duwl.htm.
267. US Environmental Protection Agency. National Primary Drinking Water Regulations, 1999. 40 CFR 1, Part 141, Subpart G. Available at http://www.epa.gov/safewater/mcl.html.
268. Bagga BS, Murphy RA, Anderson AW, Punwani I. Contamination of dental unit cooling water with oral microorganisms and its prevention. JADA 1984;109:712–6.

269. Shearer BG. Biofilm and the dental office. JADA 1996;127:181–9.
270. Garner JS, Favero MS. CDC guideline for handwashing and hospital environmental control. Infect Control 1986;7:231–43.
271. US Environmental Protection Agency. Federal Insecticide, Fungicide, and Rodenticide Act, 1972. 7 USC 6 § 136 et seq. Available at http://www4.law.cornell.edu/uscode/7/ch6schII.html.
272. Mallison GF. Hospital disinfectants for housekeeping: floors and tables. Infect Control 1984;5:537.
273. Favero MS, Bond WW. Chemical disinfection of medical and surgical materials [Chapter 43]. In: Block SS, ed. Disinfection, sterilization, and preservation. 5th ed. Philadelphia, PA: Lippincott Williams and Wilkins, 2001.
274. Rutala WA. APIC guideline for selection and use of disinfectants. Am J Infect Control 1996;24:313–42.
275. Stingeni L, Lapomarda V, Lisi P. Occupational hand dermatitis in hospital environments. Contact Dermatitis 1995;33:172–6.
276. Ashdown BC, Stricof DD, May ML, Sherman SJ, Carmody RF. Hydrogen peroxide poisoning causing brain infarction: neuroimaging findings. AM J Roentgenol 1998;170:1653–5.
277. Busch A, Werner E. Animal tolerance to peracetic acid: experimental results following the application of peracetic acid solutions on the skin of pigs [German]. Monatshefte für Veterinaermedizin 1974;29:494–8.
278. US Food and Drug Administration. Medical devices: adequate directions for use. [21 CFR Part 801.5, 807.87.e].
279. Favero MS, Bond WW. Sterilization, disinfection, and antisepsis in the hospital [Chapter 24]. In: Balows A, Hausler WJ Jr, Herrmann KL, Isenberg HD, Shadomy HJ, eds. Manual of clinical microbiology. 5th ed.Washington, DC: American Society for Microbiology, 1991:183–200.
280. Chou T. Environmental Services. In: Pfeiffer J, ed. APIC text of infection control and epidemiology. Washington, DC: Association for Professionals in Infection Control and Epidemiology, Inc., 2000;73.1–.8.
281. Rutala WA, Weber DJ. Cleaning, disinfection, and sterilization. In: Pfeiffer J, ed. APIC Text of Infection Control and Epidemiology. Washington, DC: Association for Professionals in Infection Control and Epidemiology, Inc., 2000;55.1–.6.
282. Ayliffe GA, Collins BJ, Lowbury EJ, Babb JR, Lilly HA. Ward floors and other surfaces as reservoirs of hospital infection. J Hyg (Lond) 1967;65:515–37.
283. Dancer SJ. Mopping up hospital infection. J Hosp Infect 1999;43:85–100.
284. Schmidt EA, Coleman DL, Mallison GF. Improved system for floor cleaning in health care facilities. Appl Environ Microbiol 1984;47:942–6.
285. Mallison GF. Decontamination, disinfection, and sterilization. Nurs Clin North Am 1980;15:757–67.
286. Walter CW, Kundsin RB. The floor as a reservoir of hospital infections. Surg Gynec Obstet 1960;111:412–22.
287. Scott E, Bloomfield SF. The survival and transfer of microbial contamination via cloths, hands and utensils. J Appl Bacteriol 1990;68:271–8.
288. Scott E, Bloomfield SF. Investigations of the effectiveness of detergent washing, drying and chemical disinfection on contamination of cleaning cloths. J Appl Bacteriol 1990;68:279–83.
289. Brown DG, Schatzle K, Gable T. The hospital vacuum cleaner: mechanism for redistributing microbial contaminants. J Environ Health 1980;42:192–6.
290. Wysowski DK, Flynt JW, Goldfield M, Altman R, Davis AT. Epidemic neonatal hyperbilirubinemia and use of a phenolic disinfectant detergent. Pediatrics 1978;61:165–70.
291. Doan HM, Keith L, Shennan AT. Phenol and neonatal jaundice. Pediatrics 1979;64:324–5.
292. American Academy of Pediatrics, American College of Obstetricians and Gynecologists. Infection control. In: Guidelines for perinatal care. 4th ed. Washington, DC: 1997:269–74.
293. US Department of Labor, Occupational Safety and Health Administration: 29 CFR 1910.1030. Occupational exposure to bloodborne pathogens; final rule. Federal Register 1991;56:64004–182.
294. Spire B, Montagnier L, Barré-Sinoussi F, Chermann JC. Inactivation of lymphadenopathy associated virus by chemical disinfectants. Lancet 1984;2:899–901.
295. Martin LS, McDougal JS, Loskoski SL. Disinfection and inactivation of the human T lymphotrophic virus type-III/lymphadenopathy-associated virus. J Infect Dis 1985;152:400–3.
296. Hanson PJ, Gor D, Jeffries DJ, Collins JV. Chemical inactivation of HIV on surfaces. Br Med J 1989;298:862–4.
297. Bloomfield SF, Smith-Burchnell CA, Dalgleish AG. Evaluation of hypochlorite-releasing disinfectants against the human immunodeficiency virus (HIV). J Hosp Infect 1990;15:273–8.
298. Druce JD, Jardine D, Locarnini SA, Birch CJ. Susceptibility of HIV to inactivation by disinfectants and ultraviolet light. J Hosp Infect 1995;30:167–80.
299. Van Bueren J, Simpson RA, Salman H, Farrelly HD, Cookson BD. Inactivation of HIV–1 by chemical disinfectants: sodium hypochlorite. Epidemiol Infect 1995;115:567–79.
300. Prince DL, Prince HN, Thraehart O, et al. Methodological approaches to disinfection of human hepatitis B viruses. J Clin Microbiol 1993;31:3296–3304.
301. CDC. Recommendations for prevention of HIV transmission in healthcare settings. MMWR 1987;36(Suppl No. 2S).
302. Sattar SA, Springthorpe VS. Survival and disinfectant inactivation of the human immunodeficiency virus: a critical review. Rev Infect Dis 1991;13:430–47.
303. US Department of Labor, Occupational Safety and Health Administration. EPA-registered disinfectants for HIV/HBV. Memorandum. Washington, D.C.: 1997. Available at http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=INTERPRETATIONS&p_id=22364&p_text_version=FALSE.
304. Weber DJ, Barbee SL, Sobsey MD, Rutala WA. The effect of blood on the antiviral activity of sodium hypochlorite, a phenolic, and a quaternary ammonium compound. Infect Control Hosp Epidemiol 1999;20:821–7.
305. Suzuki A, Namba Y, Matsuura M, Horisawa A. Bacterial contamination of floors and other surfaces in operating rooms: a five-year survey. J Hyg (Lond) 1984;93:559–66.
306. Richet H, McNeil M, Peters W, et al. *Aspergillus flavus* in a bone marrow transplant unit (BMTU): Pseudofungemia traced to hallway carpeting [Abstract F-23]. In: Abstracts of the 89th Annual Meeting of the American Society for Microbiology. New Orleans, LA: American Society for Microbiology, 1989:462.
307. US Department of Labor, Occupational Safety and Health Administration. Decontamination of a plush carpet surface after a spill. Standard interpretations, 1994. Available at http://www.osha.gov/pls/oshaweb/owasrch.search_form?p_doc_type=INTERPRETATIONS&p_toc_level=0&p_keyvalue=I19940610.html.
308. Taplin D, Mertz PM. Flower vases in hospitals as reservoirs for pathogens. Lancet 1973;2:1279–81.
309. Kates SG, McGinley KJ, Larson EL, Leyden JJ. Indigenous multiresistant bacteria from flowers in hospital and nonhospital environments. Am J Infect Control 1991;19:156–61.

310. Bartzokas CA, Holley MP, Sharp CA. Bacteria in flower vase water: incidence and significance in general ward practice. Br J Surg 1975;62:295–7.
311. Siegman-Igra Y, Shalem A, Berger SA, Livio S, Michaeli D. Should potted plants be removed from hospital wards? J Hosp Infect 1986;7:82–5.
312. Lass-Flörl C, Rath P, Niederwieser D, et al. *Aspergillus terreus* infections in haematological malignancies: molecular epidemiology suggests association with in-hospital plants. J Hosp Infect 2000;46:31–5.
313. Burgess NR. Hospital design and cockroach control. Trans R Soc Trop Med Hyg 1984;78:293–4.
314. Lukin LG. Human cutaneous myiasis in Brisbane: a prospective study. Med J Aust 1989;150:237–40.
315. Bruesch J. Institutional pest management: current trends. Exec Housekeep Today 1994;15:6–12.
316. Allen BW. Excretion of viable tubercle bacilli by *Blatta orientalis* (the oriental cockroach) following ingestion of heat-fixed sputum smears: a laboratory investigation. Trans R Soc Trop Med Hyg 1987;81:98–9.
317. Laszlo A. Technical guide: sputum examination for tuberculosis by direct microscopy in low income countries. 5th ed. Paris, France: International Union Against Tuberculosis and Lung Disease, 2000. Available at http://www.iuatld.org/pdf/en/guides_publications/microscopy_guide.pdf.
318. CDC. Recommendations for preventing the spread of vancomycin resistance: recommendations of the Hospital Infection Control Practices Advisory Committee (HICPAC). MMWR 1995;44 (No. RR-12).
319. Gerding DN, Johnson S, Peterson LR, Mulligan ME, Silva J Jr. *Clostridium difficile*-associated diarrhea and colitis. Infect Control Hosp Epidemiol 1995;16:459–77.
320. Weber DJ, Rutala WA. Role of environmental contamination in the transmission of vancomycin-resistant enterococci. Infect Control Hosp Epidemiol 1997;18:306–9.
321. Lai KK, Kelley AL, Melvin ZS, Belliveau PP, Fontecchio SA. Failure to eradicate vacomycin-resistant enterococci in a university hospital and the cost of barrier precautions. Infect Control Hosp Epidemiol 1998;19:647–52.
322. Byers KE, Durbin LJ, Simonton BM, Anglim AM, Adal KA, Farr BM. Disinfection of hospital rooms contaminated with vancomycin-resistant *Enterococcus faecium*. Infect Control Hosp Epidemiol 1998;19:261–4.
323. Bradley CR, Fraise AP. Heat and chemical resistance of enterococci. J Hosp Infect 1996;34:191–6.
324. Anderson RL, Carr JH, Bond WW, Favero MS. Susceptibility of vancomycin-resistant enterococci to environmental disinfectants. Infect Control Hosp Epidemiol 1997;18:195–9.
325. Saurina G, Landman D, Quale JM. Activity of disinfectants against vancomycin-resistant *Enterococcus faecium*. Infect Control Hosp Epidemiol 1997;18:345–7.
326. Rutala WA, Stiegel MM, Sarubbi FA, Weber DJ. Susceptibility of antibiotic-susceptible and antibiotic-resistant hospital bacteria to disinfectants. Infect Control Hosp Epidemiol 1997;18:417–21.
327. Sehulster LM, Anderson RL. Susceptibility of glycopeptide-intermediate resistant *Staphylococcus aureus* (GISA) to surface disinfectants, hand washing chemicals, and a skin antiseptic [Abstract Y-3]. In: Abstracts of the 98th General Meeting, American Society for Microbiology. Atlanta, GA: American Society for Microbiology, 1998.
328. Layton MC, Perez M, Heald P, Patterson JE. An outbreak of mupirocin-resistant *Staphylococcus aureus* on a dermatology ward associated with an environmental reservoir. Infect Control Hosp Epidemiol 1993; 14:369–75.
329. Karanfil LV, Murphy M, Josephson A, et al. A cluster of vancomycin-resistant *Enterococcus faecium* in an intensive care unit. Infect Control Hosp Epidemiol 1992;13:195–200.
330. Boyce JM, Opal SM, Chow JW, et al. Outbreak of multidrug-resistant *Enterococcus faecium* with transferable *vanB* class vancomycin resistance. J Clin Microbiol 1994;32:1148–53.
331. Rhinehart E, Smith NE, Wennersten C, et al. Rapid dissemination of beta-lactamase-producing, aminoglycoside-resistant *Enterococcus faecalis* among patients and staff on an infant-toddler surgical ward. N Engl J Med 1990;323:1814–8.
332. Livornese LL Jr, Dias S, Samel C, et al. Hospital-acquired infection with vancomycin-resistant *Enterococcus faecium* transmitted by electronic thermometers. Ann Intern Med 1992;117:112–6.
333. Zervos MJ, Kauffman CA, Therasse PM, Bergman AG, Mikesell TS, Schaberg DR. Nosocomial infection by gentamicin-resistant *Streptococcus faecalis*: an epidemiologic study. Ann Intern Med 1987;106:687–91.
334. Worsley MA. Infection control and prevention of *Clostridium difficile* infection. J Antimicrobial Chemother 1998;41(suppl C):59–66.
335. Lloyd-Evans N, Springthorpe VS, Sattar SA. Chemical disinfection of human rotavirus-contaminated inanimate surfaces. J Hyg (Lond) 1986;97:163–73.
336. Rutala WA, Weber DJ. Creutzfeldt-Jakob disease: recommendations for disinfection and sterilization. Clin Infect Dis 2001;32:1348–56.
337. Kimberlin RH, Walker CA, Millson GC, et al. Disinfection studies with two strains of mouse-passaged scrapie agent: guidelines for Creutzfeldt-Jakob and related agents. J Neurol Sci 1983;59:355–69.
338. Rosenberg RN, White CL, Brown P, et al. Precautions in handling tissues, fluids, and other contaminated materials from patients with documented or suspected Creutzfeldt-Jakob disease. Ann Neurol 1986;19:75–7.
339. Taylor DM. Inactivation of the unconventional agents of scrapie, bovine spongiform encephalopathy, and Creutzfeldt-Jakob disease. J Hosp Infect 1991; 18(suppl A):141–6.
340. Budka H, Aguzzi A, Brown P, et al. Tissue handling in suspected Creutzfeldt-Jakob disease (CJD) and other human spongiform encephalopathies (prion diseases). Brain Pathol 1995;5:319–22.
341. Ironside JW, Bell JE. The 'high-risk' neuropathological autopsy in AIDS and Creutzfeldt-Jakob disease: principles and practice. Neuropathol Appl Neurobiol 1996;22:388–93.
342. World Health Organization. WHO infection control guidelines for transmissible spongiform encephalopathies: report of a WHO consultation. Geneva, Switzerland: World Health Organization, 1999. Available at http://www.who.int/emc-documents/tse/whocdscsraph2003c.html.
343. Bond WW, Sehulster LM. Microbiological assay of environmental and medical-device surfaces [Section 11]. In: Isenberg HD, ed. Clinical microbiology procedures.Washington, DC: American Society for Microbiology Press, 2003 (in press).
344. Clesceri LS, Greenberg AE, Eaton AD, eds. Standard methods for the examination of water and wastewater. 20th ed. Washington, DC: American Public Health Association, American Water Works Association, Water Environment Foundation, 1998:9-1–9-41.
345. Buttner MP, Willeke K, Grinshpun SA. Sampling and analysis of airborne microorganisms [Chapter 68]. In: Manual of environmental microbiology. Hurst CJ, Knudsen GR, McInerney MJ, Stetzenbach LD, Walter MV, eds. Washington, DC: American Society for Microbiology Press, 1997:629–40.

346. Jensen PA, Schafer MP. Sampling and characterization of bioaerosols. In: NIOSH manual of analytical methods. Cincinnati, OH: US Department of Health and Human Services, National Institute for Occupational Safety and Health, 1998:82–112. Available at http://www.cdc.gov/niosh/nmam/pdfs/chapter-j.pdf.
347. International Organization for Standardization. Sterilization of medical devices—microbiological methods [Part 1]. Paramus, NJ: International Organization for Standardization, 1995. ISO Standard 11737-1.
348. Streifel AJ. Air cultures for fungi. In: Isenberg HD, ed. Clinical microbiology procedures handbook. Washington, DC: American Society for Microbiology Press, 1992:11.8.1–.7.
349. Wolf HW, Skaliy P, Hall LB, et al. Sampling microbiological aerosols. Washington, DC: US Department of Health, Education and Welfare, Public Health Service, 1964. Public Health Service publication no. 686. (Monograph no. 60).
350. Wagner RA. Partitioned laundry improves bacteria control. Hospitals JAHA 1966;40:148–51.
351. Hambraeus A, Malmborg AS. Is a bed centre in a hospital a hygienic hazard? J Hyg (Lond) 1982;88:143–7.
352. McDonald LL, Pugliese G. Textile processing service [Chapter 66]. In: Mayhall CG, ed. Hospital epidemiology and infection control. 2nd ed. Philadelphia, PA: Lippincott Williams and Wilkins, 1999:1031–4.
353. Barrie D, Hoffman PN, Wilson JA, Kramer JM. Contamination of hospital linen by *Bacillus cereus*. Epidemiol Infect 1994;113:297–306.
354. Legnani PP, Leoni E. Factors affecting the bacteriological contamination of commercial washing machines [German]. Zentralbl Hyg 1997;200:319–33.
355. Joint Committee on Healthcare Laundry Guidelines. Guidelines for healthcare linen service. Hallendale, FL: Textile Rental Service Association of America, 1999.
356. Greene VW. Microbiological contamination control in hospitals: part 6 — roles of central service and the laundry. Hospitals JAHA 1970;44:98–103.
357. Association for the Advancement of Medical Instrumentation. Processing of reusable surgical textiles for use in health care facilities: ANSI/AAMI Recommended Practice ST65:2000; Arlington, VA: Association for the Advancement of Medical Instrumentation, 2000:16.
358. Hughes HG. Chutes in hospitals. Can Hosp 1964;41:56–7,87.
359. Michaelsen GS. Designing linen chutes to reduce spread of infectious organisms. Hospitals JAHA 1965;39:116–9.
360. Hoch KW. Laundry chute cleaning recommendations [Letter]. Infect Control 1982;3:360.
361. Whyte W, Baird G, Annand R. Bacterial contamination on the surface of hospital linen chutes. J Hyg (Lond) 1969;67:427–35.
362. Taylor LJ. Segregation, collection, and disposal of hospital laundry and waste. J Hosp Infect 1988;11(suppl A):57–63.
363. Walter WG, Schillinger JE. Bacterial survival in laundered fabrics. Appl Microbiol 1975; 29:368–73.
364. Belkin NL. Aseptics and aesthetics of chlorine bleach: can its use in laundering be safely abandoned? Am J Infect Control 1998;26:149–51.
365. Blaser MJ, Smith PE, Cody HJ, Wang WL, LaForce FM. Killing of fabric-associated bacteria in hospital laundry by low-temperature washing. J Infect Dis 1984;149:48–57.
366. Jaska JM, Fredell DL. Impact of detergent systems on bacterial survival on laundered fabrics. Appl Environ Microbiol 1980;39:743–8.
367. Battles DR, Vesley D. Wash water temperature and sanitation in the hospital laundry. J Environ Health 1981;43:244–50.
368. Christian RR, Manchester JT, Mellor MT. Bacteriological quality of fabrics washed at lower-than-standard temperatures in a hospital laundry facility. Appl Environ Microbiol 1983;45:591–7.
369. Smith JA, Neil KR, Davidson CG, Davidson RW. Effect of water temperature on bacterial killing in laundry. Infect Control 1987;8:204–9.
370. Tompkins DS, Johnson P, Fittall BR. Low-temperature washing of patients' clothing: effects of detergent with disinfectant and a tunnel drier on bacterial survival. J Hosp Infect 1988;12:51–8.
371. Ayliffe GA, Collins BJ, Taylor LJ. Laundering [Chapter 11]. In: Hospital-acquired infection: principles and prevention. Bristol, UK: John Wright and Sons,1982:101–6.
372. Meyer CL, Eitzen HE, Schreiner RL, Gfell MA, Moye L, Kleiman MB. Should linen in newborn intensive care units be autoclaved? Pediatrics 1981;67:362–4.
373. Wagg RE. Disinfection of textiles in laundering and dry cleaning. Chemistry and Industry 1965;44:1830–4.
374. Bates CJ, Wilcox MH, Smith TL, Spencer RC. The efficacy of a hospital dry cleaning cycle in disinfecting material contaminated with bacteria and viruses. J Hosp Infect 1993;23:255–62.
375. Oehnel E. Drycleaning in the hospital laundry. Can Hosp 1971;48:66–7.
376. US Environmental Protection Agency. Consumer Products Treated with Pesticides. Office of Pesticide Programs. Available at http://www.epa.gov/pesticides/factsheets/.
377. Fujita K, Lilly HA, Kidson A, Ayliffe GA. Gentamicin-resistant *Pseudomonas aeruginosa* infection from mattresses in a burns unit. Br Med J 1981;283:219–20.
378. Grubb DJ, Watson KC. *Pseudomonas* septicaemia from plastic mattresses [Letter]. Lancet 1982;1:518.
379. Sherertz RJ, Sullivan ML. An outbreak of infections with *Acinetobacter calcoaceticus* in burn patients: contamination of patients' mattresses. J Infect Dis 1985;151:252–8.
380. Ndawula EM, Brown L. Mattresses as reservoirs of epidemic methicillin-resistant *Staphylococcus aureus* [Letter]. Lancet 1991;337:488.
381. O'Donoghue MA, Allen KD. Costs of an outbreak of wound infections in an orthopaedic ward. J Hosp Infect 1992;22:73–9.
382. Weernink A, Severin WP, Tjernberg I, Dijkshoorn L. Pillows, an unexpected source of *Acinetobacter*. J Hosp Infect 1995;29:189–99.
383. Scheidt A, Drusin LM. Bacteriologic contamination in an air-fluidized bed. J Trauma 1983;23:241–2.
384. Freeman R, Gould FK, Ryan DW, Chamberlain J, Sisson PR. Nosocomial infection due to *Enterococci* attributed to a fluidized microsphere bed. The value of pyrolysis mass spectrometry. J Hosp Infect 1994;27:187–93.
385. Clancy MJ. Nosocomial infection and microsphere beds [Letter]. Lancet 1993;342:680–1.
386. Clancy MJ. Nosocomial infection due to *Enterococci* attributed to a fluidized microsphere bed [Letter]. J Hosp Infect 1994;28:324–5.
387. Jacobsen E, Gurevich I, Cunha BA. Air-fluidized beds and negative-pressure isolation rooms [Letter]. Am J Infect Control 1993;21:217–8.
388. American Academy of Allergy, Asthma, and Immunology. Tips to remember: indoor allergens. Milwaukee, WI: American Academy of Allergy, Asthma, and Immunology. Available at http://www.aaaai.org/patients/publicedmat/tips/indoorallergens.stm.
389. Duncan SL, APIC Guideline Committee. APIC state-of-the-art report: the implications of service animals in healthcare settings. Am J Infect Control 2000;28:170–80.

390. Murray AB, Ferguson AC, Morrison BJ. The frequency and severity of cat allergy vs. dog allergy in atopic children. J Allergy Clin Immunol 1983;72:145–9.
391. Delta Society. Standards of practice for animal-assisted activities and animal-assisted therapy. Renton, WA: Delta Society, 1996.
392. Fox JG. Transmissible drug resistance in *Shigella* and *Salmonella* isolated from pet monkeys and their owners. J Med Primatol 1975;4:165–71.
393. Ostrowski SR, Leslie MJ, Parrott T, Abelt S, Piercy PE. B-virus from pet macaque monkeys: an emerging threat in the United States? Emerg Infect Dis 1998;4:117–21.
394. Saylor K. Pet visitation program. J Gerontol Nurs 1998;24:36–8.
395. Draper RJ, Gerber GJ, Layng EM. Defining the role of pet animals in psychotherapy. Psychiatr J Univ Ottawa 1990;15:169–72.
396. CDC. USPHS/IDSA guidelines for the prevention of opportunistic infections in persons infected with human immunodeficiency virus. MMWR 1999;48(No. RR-10).
397. CDC. Reptile-associated salmonellosis — selected states, 1996–1998. MMWR 1999;48:1009–13.
398. US Department of Justice. Americans With Disabilities Act. Nondiscrimination on the basis of disability by public accommodations and in commercial facilities. Public Law 101-336. Title III, Public accomodations operated by private entities, Sect. 302. Prohibition of discrimination by public accomodations, 42 USC 12101 et seq., 1990.
399. US Department of Agriculture. Public Law 99-198. Food Security Act of 1985, Subtitle F — Animal Welfare. Title 7, United States Code, Chapter 54, Section 2131.
400. CDC, National Institutes of Health. Biosafety in microbiological and biomedical laboratories. 4th ed. Washington, DC: US Department of Health and Human Services, Public Health Service, CDC; DHHS publication no. (CDC) 93-8395.
401. US Department of Labor, Occupational Safety and Health Administration. Personal protective equipment for general industry; final rule. 29 CFR 1910 § 1910.132, 1910.138. Federal Register 1994;59:16334–64.
402. US Department of Transportation. Hazardous Materials Regulations. 49 CFR Parts 171–180, Division 6.2; and Hazardous materials: revision to standards for infectious substances and genetically-modified microorganisms; proposed rule. Federal Register 1998;63:46843–59.
403. US Postal Service. C 023.8.0 Hazardous materials: infectious substances (hazard class 6, division 6.2). Washington, D.C.: US Government Printing Office. Available at http://pe.usps.gov/text/dmm/c023.htm.
404. Greene R, Miele DJ, Slavik NS. Technical assistance manual: state regulatory oversight of medical waste treatment technologies, 2nd ed. State and Territorial Association on Alternative Treatment Technologies, 1994.
405. National Institute for Occupational Safety and Health. NIOSH alert: preventing needlestick injuries in health care settings. Cincinnati, OH: US Department of Health and Human Services, National Institute for Occupational Safety and Health, 1999. DHHS (NIOSH) publication no. 2000-108.
406. Weber AM, Boudreau Y, Mortimer VD. Health hazard evaluation report: Stericycle, Inc., Morton, WA. Cincinnati, OH: National Institute for Occupational Safety and Health, Hazard Evaluations and Technical Assistance Branch, 1998. HETA 98-0027-2709.
407. Johnson KR, Braden CR, Cairns KL, et al. Transmission of *Mycobacterium tuberculosis* from medical waste. JAMA 2000;284:1683–8.
408. Emery R, Sprau D, Lao YJ, Pryor W. Release of bacterial aerosols during infectious waste compaction: an initial hazard evaluation for healthcare workers. Am Ind Hyg Assoc J 1992;53:339–45.
409. US Department of Health and Human Services, CDC. Additional requirements for facilities transferring or receiving select agents; final rule. 42 CFR Part 72. Federal Register 1996;61(207):55189–200.
410. CDC, Office of Biosafety, Hospital Infections Program. Recommendations on infective waste, Atlanta, GA: Department of Health and Human Services, CDC, 1988:1–6.

Appendix

Water Sampling Strategies and Culture Techniques for Detecting Legionellae

Legionella spp. are ubiquitous and can be isolated from 20%–40% of freshwater environments, including man-made water systems (*1,2*). In health-care facilities, where legionellae in potable water rarely result in disease among nonimmunocompromised patients, courses of remedial action are unclear.

Scheduled microbiologic monitoring for legionellae remains controversial because the presence of legionellae is not necessarily evidence of a potential for causing disease (*3*). CDC recommends aggressive disinfection measures for cleaning and maintaining devices known to transmit legionellae, but does not recommend regularly scheduled microbiologic assays for the bacteria (*4*). However, scheduled monitoring of potable water within a hospital might be considered in certain settings where persons are highly susceptible to illness and mortality from *Legionella* infection (e.g., hematopoietic stem cell transplantation units and solid organ transplant units) (*5*). Also, after an outbreak of legionellosis, health officials agree monitoring is necessary to identify the source and to evaluate the efficacy of biocides or other prevention measures.

Examination of water samples is the most efficient microbiologic method for identifying sources of legionellae and is an integral part of an epidemiologic investigation into health-care–associated Legionnaires' disease. Because of the diversity of plumbing and HVAC systems in health-care facilities, the number and types of sites to be tested must be determined before collection of water samples. One environmental sampling protocol that addresses sampling site selection in hospitals might serve as a prototype for sampling in other institutions (*6*). Any water source that might be aerosolized should be considered a potential source for transmission of legionellae. The bacteria are rarely found in municipal water supplies and tend to colonize plumbing systems and point-of-use devices. To colonize, legionellae usually require a temperature range of 77°F–108°F (25°C–42.2°C) (*7*) and are most commonly located in hot water systems. Legionellae do not survive drying. Therefore, air-conditioning equipment condensate, which frequently evaporates, is not a likely source (*8*).

Water samples and swabs from point-of-use devices or system surfaces should be collected when sampling for legionellae (Box 1, Box 2 in text) (*9*). Swabs of system surfaces allow sampling of biofilms, which frequently contain legionellae. When culturing faucet aerators and shower heads, swabs of surface areas should be collected first; water samples are collected after aerators or shower heads are removed from their pipes. Swabs can be streaked directly onto buffered charcoal yeast extract agar plates if the plates are available at the collection site. If the swabs and water samples must be transported back to a laboratory for processing, immersing individual swabs in sample water minimizes drying during transit. Place swabs and water samples in insulated coolers to protect specimens from temperature extremes.

References

1. Arnow PM, Weil D, Para MF. Prevalence and significance of *Legionella pneumophila* contamination of residential hot- tap water systems. J Infect Dis 1985;152:145–51.
2. Shelton BG, Morris GK, Gorman GW. Reducing risks associated with *Legionella* bacteria in building water systems. In: Legionella: current status and emerging perspectives. Barbaree JM, Breiman RF, Dufour AP, eds. Washington DC: American Society for Microbiology Press, 1993:279–81.
3. Joly JR. Monitoring for the presence of *Legionella*: where, when, and how? In: Legionella: current status and emerging perspectives. Barbaree JM, Breiman RF, Dufour AP, eds. Washington DC: American Society for Microbiology Press, 1993:211–6.
4. Hoge CW, Breiman RF. Advances in the epidemiology and control of *Legionella* infections. Epidemiol Rev 1991;13:329–40.
5. CDC. Guidelines for preventing opportunistic infections among hematopoietic stem cell transplant recipients. MMWR 2000;49(No. RR-10).
6. Barbaree JM, Gorman GW, Martin WT, Fields BS, Morrill WE. Protocol for sampling environmental sites for Legionellae. Appl Environ Microbiol 1987;53:1454–8.
7. Brenner DJ, Feeley JC, Weaver RE. Family VII. Legionellaceae. In: Bergey's manual of systemic bacteriology. Vol. 1. Krieg NR, Holt JG, eds. Baltimore, MD: Williams and Wilkins, 1984:279–88.
8. Katz SM, Hammel JM. The effect of drying, heat, and pH on the survival of *Legionella pneumophila*. Ann Clin Lab Sci 1987;17:150–6.
9. CDC. Procedures for the recovery of *Legionella* from the environment. Atlanta, GA: US Department of Health and Human Services, Public Health Service, CDC, 1992:1–13.

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Supplement 1: Isolation facilities in acute settings

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Contents

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1 Introduction

CONTEXT

1.1 Healthcare associated infection (HCAI) is a burden on the NHS. It affects an estimated one in ten NHS hospital patients each year (DH, 2003) at an annual cost of £1 bn (National Audit Office, 2000).

1.2 Many patients with an infection require physical isolation. However, often patients cannot be isolated because of a shortage of single rooms and isolation suites. In 2003 the Chief Medical Officer directed that 'NHS Trust chief executives will ensure, over time, that there is appropriate provision of isolation facilities within their healthcare facilities' (DH, 2003, Action area 3).

1.3 The key to effective isolation on acute general wards is the provision of single rooms with en-suite sanitary facilities. Single rooms reduce the risk of cross-infection for non-airborne diseases and help to lower the incidence of HCAI. Most patients on acute general wards can be isolated in single rooms with en-suite facilities. All single rooms in new-build hospitals should have en-suite facilities so that they can be used to isolate patients, among other reasons.

PURPOSE OF THE GUIDANCE

1.4 This supplement to HBN 4 – 'In-patient accommodation: options for choice', NHS Estates, 1997 (new edition in preparation) provides guidance on the facilities required for isolating patients on acute general wards.

1.5 For infection control purposes any kind of single room with en-suite is better than no single room at all. However, the guidance in this supplement is based on best practice, and describes how a single room can be enhanced to provide an effective isolation facility for patients on acute general wards. The supplement has two aims:

- to set a standard for new-build facilities;
- to provide trusts wishing to convert existing accommodation with simple design options that can be implemented relatively quickly and cost-effectively.

1.6 This guidance:

- explains how a single room with en-suite sanitary facilities can be enhanced to provide effective isolation for patients with infections transmitted through contact or by the faecal-oral route;
- describes how an enhanced single room with en-suite facilities and a ventilated lobby can provide an isolation suite for patients who have airborne infections or who need to be protected from them;
- can be used for both new-build schemes and the upgrading of existing accommodation.

1.7 The guidance also contains examples of room layouts.

1.8 The guidance on isolation suites in this supplement is based on a theoretical design model. The model will be validated in the near future, and the results published in a separate document. The aim of this supplement is to provide practical guidance on how to provide isolation facilities that are simple to use and meet the needs of the majority of patients on acute general wards.

1.9 Information about how good design can prevent cross-infection in healthcare premises generally is provided in HFN 30 – 'Infection control in the built environment: design and planning' (NHS Estates, 2002). This supplement should be read in conjunction with HFN 30.

EXCLUSIONS

1.10 This supplement does not describe the specialist facilities required in infectious disease units or on wards where severely immuno-compromised patients are nursed. Guidance for these facilities will follow in a further supplement to HBN 4.

2 Operational policies and planning principles

THE NEED TO ISOLATE PATIENTS

2.1 Historically, isolation in general wards has been provided in single rooms, sometimes without en-suite facilities. Rooms without en-suite facilities often cannot be used to isolate patients effectively.

2.2 Ventilated isolation suites with en-suite facilities have also been provided. They may have a ventilation system that provides a positive pressure in the room to protect the patient from infection, or a negative pressure to prevent a patient from infecting others, or the ventilation may be switchable from positive to negative. These rooms rely on staff being able to assess the type of ventilation required when a patient arrives on the ward and, for switchable systems, knowing how to select the correct ventilation mode. Patients can be put at risk if the ventilation mode is not set correctly.

2.3 The provision of isolation rooms that are switchable from positive to negative air pressure is no longer recommended because of the risk to people inside and outside the room in the event of the setting being incorrect.

2.4 There are four main reasons for caring for patients in single rooms:

- patient susceptibility to infection from other sources;
- where a patient presents an infection risk to others;
- non-medical, for example patient preference;
- clinical but not infection-related.

In terms of infection control, only patients in the first two categories require isolation. Patients in the latter two categories can be cared for in standard single en-suite rooms.

ISOLATION FACILITIES

2.5 In order to simplify the use of isolation facilities, this supplement proposes two room designs for isolating patients in acute general settings:

- enhanced single room with en-suite facilities;
- enhanced single room with en-suite facilities and ventilated lobby (isolation suite).

Enhanced single room with en-suite facilities

2.6 An enhanced single room with en-suite sanitary facilities having extract ventilation is a simple, cost-effective way to provide isolation, and will meet the needs of most patients on general wards.

2.7 The room does not require any specialist knowledge or action by the nursing staff to operate it. When not being used for isolation the room can be used for general nursing.

2.8 See paragraph 3.1 for detailed design guidance.

Enhanced single room with en-suite facilities and ventilated lobby (isolation suite)

2.9 An enhanced single room with a positive pressure ventilated entry lobby and en-suite facilities with extract ventilation provides both source and protective isoaltion.

2.10 The positive pressure lobby ensures that air from the corridor does not enter the isolation room, and that air from the room does not escape into the corridor. This simple design enables the suite to be used for both source and protective isolation without the need for switchable ventilation or special training for staff. It also provides safe isolation for patients whose exact condition is unknown.

2.11 See paragraph 3.4 for detailed design guidance.

Advantages

2.12 Both rooms are suitable for caring for patients not in isolation but who require a single room for other reasons. In addition, both room designs are simple in concept, by default safe in operation, and do not require the nursing staff to have any specialist ventilation knowledge.

CREATING PLEASANT ENVIRONMENTS

2.13 Some patients with infections need to stay in isolation in hospital for long periods of time. The number of visitors they receive and the length of time they can spend with them may be restricted. This means that patients who are already vulnerable, but not necessarily physically severely incapacitated, will be confined to the room for sometimes several weeks and can experience long periods of boredom.

2.14 Accommodation for these patients should be stimulating and as comfortable as possible. Designers should try to achieve a balance between the need for a clean environment and the comfort of patients. There are a number of publications that describe in detail evidence that supports the concept that a therapeutic environment has a positive effect on a patient's general feeling of well-being; reduces the length of stay for many patients; reduces depression, confusion and aggressive episodes; and significantly increases a patient's level of satisfaction with the overall quality of their care.

2.15 If patients are to stay in an isolation suite, it is important that they are able to see staff from their beds. Staff should also be able to see the patient in case of emergency. This reduces the psychological problems of isolation. Observation windows should have integral privacy blinds which can be controlled by both staff and patients. The sense of containment can also be reduced by providing outside views using windows with low sills.

RECORD KEEPING

2.16 Where staff are required to record lobby air pressures as part of the local COSHH assessment, facilities for completing and storing log books should be provided in the lobby.

MAINTENANCE AND CLEANING

2.17 Guidance on the maintenance and cleaning of materials and finishes is contained in HFN 30 (NHS Estates, 2002). Planning teams should also refer to the NHS Cleaning Manual (NHS Estates, 2004).

Above: single room; left: en-suite bathroom

3 Design guidance

NEW BUILD ISOLATION FACILITIES

Enhanced single room with en-suite facilities

3.1 The design for a new-build enhanced single room with en-suite facilities is shown in Sheet 1 (see Appendix I: Example room layouts).

3.2 The general specification for single rooms is provided in HBN 4 (1997). The enhancements and modifications recommended for isolating patients are:

- a clinical hand-wash basin, with non-touch, fixed temperature mixer tap, adjacent to the exit door;
- wall-mounted soap dispensers, disinfectant hand rub dispensers, and disposable towel holders;
- a bin for disposing of paper towels and other non-clinical items;
- suitable extract to the en-suite bathroom;
- transfer grille in en-suite door;
- en-suite WC to be non-touch flush and hand-wash basin to have single tap with flow and temperature control;
- windows should be openable, but with a fixed maximum opening width for safety. They should also be lockable;
- observation window in corridor wall with integral privacy blinds that can be controlled by both patients and staff;
- all windows, including observation windows, should be low enough to provide a view for patients lying in bed.

Enhanced single room with en-suite facilities and ventilated lobby (isolation suite)

3.3 The design for a new-build enhanced single room with en-suite facilities and ventilated lobby, with bed access through the lobby, is shown in Sheet 2 (see Appendix I: Room layouts).

3.4 The ventilated lobby ensures that:

- air entering the bedroom is the clean ventilation supply from the lobby. Air from the corridor is blocked by the ventilation supply in the lobby, that is, the patient in the bedroom is protected from air from the corridor;
- potentially contaminated air from the bedroom is prevented from escaping into the corridor by the ventilated lobby, so the patient will not present a risk of infection to others.

Because the lobby simultaneously prevents unfiltered air entering the room and potentially contaminated air escaping from it, the room can be used by both infectious patients and those at risk of infecting others.

3.5 The use of personal protective equipment (PPE) will be determined by local infection control policy. Facilities for putting on and removing PPE, and washing hands, are provided in the lobby. The risk of contaminants being dislodged from used PPE by the ventilation system and blown out into the corridor is considered negligible. However, a hand-wash basin and disposal bin are also provided in the bedroom close to the exit door so that PPE can be removed in the bedroom should local policy require.

3.6 The benefits of the isolation suite are that it is simple in concept, requires no specialist knowledge by the nursing staff to operate it, and can also be used for general nursing. In addition, if the ventilation system fails the layout of the suite still ensures a degree of protection.

3.7 The general specification for single rooms is provided in HBN 4. The enhancements and modifications recommended for isolating patients are:

In the lobby:

- a clinical hand-wash basin with non-touch, fixed temperature mixer tap;
- wall-mounted soap dispensers, disinfectant hand rub dispensers, and disposable towel holders;
- wall-mounted plastic apron and glove dispensers and storage for other clean PPE items;
- a clinical waste bin for disposal of used PPE;
- a bin for disposing of paper towels and other non-clinical items;

- storage for room cleaning equipment;
- a suitable air supply.

In the bedroom:

- a clinical hand-wash basin, with non-touch, fixed temperature mixer tap, adjacent to the exit door;
- wall-mounted soap dispensers, disinfectant hand rub dispensers, and disposable towel holders;
- a clinical waste bin for disposal of used PPE;
- observation window in corridor wall with integral privacy blinds;
- a pressure stabiliser above bedroom door.

In the en-suite bathroom:

- suitable extract system to the en-suite bathroom;
- transfer grille in the en-suite door;
- en-suite WC to be non-touch flush and wash basin to have single tap with flow and temperature control.

For the suite as a whole:

- sealed, solid ceiling;
- windows to the exterior to be locked shut and sealed.

3.8 Heating and cooling of the isolation suite will be provided via the ventilation system.

3.9 The provision of a two-way intercommunication system between the patient's bedroom and the nurses' base should be considered.

CONVERTING EXISTING FACILITIES

3.10 The majority of patients requiring isolation can be cared for in enhanced single rooms with en-suite facilities that have an extract system. Only a small number of patients will need an isolation suite.

3.11 Acute general hospitals can create enhanced single en-suite rooms and isolation suites by converting bays and adapting existing single room accommodation. The layout of existing facilities may impose constraints on design, however, and planning teams will sometimes have to resolve the conflict between what is desirable and what is achievable.

3.12 For trusts wanting to convert existing accommodation into isolation facilities, the easiest and least expensive option is to adapt existing single rooms with en-suite sanitary facilities (see paragraph 3.13). However, where existing single rooms do not have en-suite facilities, trusts will need to reconfigure the accommodation (see paragraph 3.16).

Converting a single room with en-suite facilities

3.13 The standard furnishing and fitment requirements for a single room are described in HBN 4 – 'In-patient accommodation: options for choice' (NHS Estates, 1997). Planning teams should also refer to the revised schedules of accommodation available from the Knowledge and Information Portal at http://www.nhsestates.gov.uk.

3.14 The additional requirements for isolation of a single en-suite room are:

- a clinical hand-wash basin, with non-touch, fixed temperature mixer tap, adjacent to the exit door;
- upgrade the extract system if necessary;
- a transfer grille in the en-suite door;
- en-suite WC to be non-touch flush and wash basin to have single tap with flow and temperature control;
- an observation window in the corridor wall with integral privacy blinds that can be controlled by both patients and staff;
- all windows, including observation windows, should be low enough to provide a view for patients lying in bed.

3.15 A typical layout for converting an existing single room with en-suite facilities is shown in Sheet 3 (see Appendix I: Example room layouts).

Converting a single room without en-suite facilities

3.16 In an existing building it may be possible to modify three adjacent single bedrooms into two enhanced single bedrooms each with en-suite facilities – see Sheet 4 (in Appendix I: Example room layouts).

3.17 The requirements for disabled access, as set out in Part M of the Building Regulations, should be met.

Creating an enhanced single room with en-suite facilities and ventilated lobby (isolation suite)

3.18 When converting a single room into an enhanced single room with en-suite and ventilated lobby, any suspended ceiling must be replaced with a sealed solid ceiling. If a single room has a suspended ceiling to permit access to overhead services, a trust could install a sealed ceiling with sealable access hatches or move the services.

3.19 The additional requirements for upgrade to an isolation suite are:

In the lobby:

- a clinical hand-wash basin with non-touch, fixed temperature mixer tap;
- wall-mounted soap dispensers, disinfectant hand rub dispensers, and disposable towel holders;
- wall-mounted plastic apron and glove dispensers and storage for other clean PPE items;
- a clinical waste bin for disposal of used PPE;
- a bin for disposing of paper towels and other non-clinical items;
- storage for room cleaning equipment;
- a suitable air supply.

In the bedroom:

- a clinical hand-wash basin, with non-touch, fixed temperature mixer tap, adjacent to the exit door;
- a clinical waste bin for disposal of used PPE;
- observation window in corridor wall with integral privacy blinds;
- a pressure stabiliser above the bedroom door.

In the en-suite bathroom:

- suitable extract system to the en-suite bathroom;
- transfer grille in the en-suite door;
- en-suite WC to be non-touch flush and wash basin to have single tap with flow and temperature control.

For the suite as a whole:

- sealed, solid ceiling;
- windows to the exterior to be locked shut and sealed.

3.20 The provision of a two-way intercommunication system between the patient's bedroom and the nurses' base should be considered.

3.21 An option for reconfiguring two existing single rooms to provide one enhanced single room with en-suite facilities and ventilated lobby, with bed access through the lobby, is shown in Sheet 5 (see Appendix I: Example room layouts). Where space restrictions mean bed access through the lobby is not possible, an alternative layout gives bed access directly to the bedroom from the corridor, see Sheet 6 (in Appendix I: Example room layouts).

Converting a multi-bed bay

3.22 An existing four-bed bay may be converted to provide two enhanced single rooms with en-suite facilities (see Sheet 7 in Appendix I: Example room layouts).

3.23 In this configuration it is not possible to provide a normal observation window. As observation is critical, however, one option would be to provide fully-glazed lobby and bedroom doors, with integral privacy blinds, to enable observation from the corridor and to provide a view out for the patient.

Hand rub dispenser

4 Engineering requirements

ENGINEERING DESIGN PHILOSOPHY

4.1 This chapter describes the ventilation system philosophy for an isolation suite with a patient's bedroom, en-suite sanitary facilities and ventilated lobby. A methodology for validation of the performance standard is given in Appendix II.

4.2 The isolation suite and its ventilation system are based on a theoretical design, which will be validated in the near future (see paragraph 1.7). The engineering guidance given in this chapter aims to provide a practical, "fail-safe" design solution for isolating patients on acute general wards.

4.3 The ventilation system is designed on the basis that all its constituent parts, as described in the table below, work together to form an integrated system. For example, air to the suite is supplied at high level in the lobby, with extract in the en-suite bathroom. This ensures good air flow through the entire isolation suite. Similarly, the volumetric air flow rate in the lobby is determined by the number of air changes required in the patient's bedroom, which will be determined by the size of the bedroom. Modifying or failing to provide one element of the system will jeopardise the performance of the system as a whole.

BASIC DESIGN PARAMETERS

4.4 The patient's bedroom is to have 10 air changes per hour. The entry lobby is to be at +10 pascals with respect to the corridor. The en-suite room is to have at least 10 air changes per hour and be at a negative pressure with respect to the patient's bedroom. Table 1 gives nominal design values calculated for rooms of the size stated.

TABLE 1: ISOLATION SUITE – VENTILATION PARAMETERS

ROOM	PARAMETER	NOMINAL DESIGN VALUES
LOBBY	Room volume Bed access lobby (5 m^2 x 2·7 m) Personnel access lobby (4 m^2 x 2·7 m)	 13·5 m^3 10·8 m^3
	Pressure differential to corridor	Nominally 10 pascals
	Supply air flow	Bed access lobby – 238 l/s Personnel access lobby – 208 l/s
	Air change rate	Bed access lobby – 63 per hour Personnel access lobby – 69 per hour
ISOLATION ROOM	Room volume (19 m^2 x 3 m)	57 m^3
	Pressure differential to corridor	Nominally zero
	Room air flow	158 l/s
	Air changes rate	10 per hour
EN-SUITE	Room volume (6 m^2 x 2·7 m)	16·2 m^3
	Pressure differential to isolation room	Negative
	Extract air flow	158 l/s (If extract is fitted in the isolation room this reduces to 45 l/s in the en-suite with 113 l/s extract in the isolation room)
	Air change rate	At least 10 per hour

Note

1. In this example the design parameters are based on HBN 4 – 'In-patient accommodation: options for choice'. The en-suite is sized to comply with BS 8300 accessibility requirements.
2. The air flow rates quoted do not include any allowance for construction leakage. This has been set at 1 l/s of air per 1 m^3 of suite envelope volume (see Appendix II).

ISOLATION SUITE

Ventilation – general

4.5 Ideally each suite should have its own dedicated supply and extract system. If two or more suites share a ventilation system there will be an inevitable increase in the complexity of the system and a corresponding reduction in reliability and serviceability. Further complications will occur when individual suites have to be isolated for deep cleaning following occupation. Routine maintenance of the ventilation system will result in complete closure of all suites that it serves. For these reasons it is strongly recommended that each suite should have its own ventilation system.

4.6 The object should be to keep the ventilation systems as simple as possible. Standby fans or motors are not required for either supply or extract. This is because the system as designed is robust enough to withstand fan failure without significantly compromising the level of protection. A flow sensor should be fitted to each system that will alarm on fan failure at a designated nurse station and the estates department.

4.7 Ductwork should be kept as direct and simple as possible. In order to facilitate duct cleaning, volume control devices and other obstructions in the distribution ducts should be avoided. Supply and extract flow rates should, where possible, be set by terminal and duct size design. In the unlikely event that volume control devices are required, iris dampers are the preferred type.

4.8 In a high-rise building a common supply and extract system may be the only feasible solution. In this case, run and standby fans would be required for the extract and a duplicate supply unit may be considered necessary. The supply and extract branches to each isolation suite should be fitted with spring-close gas-tight dampers. This will permit individual suites to be shut down for cleaning and maintenance. The common supply and extract systems will need to be controlled to ensure a constant volume in each isolation suite branch regardless of the number in use. The overall design should ensure that short-circuiting cannot occur between isolation suites.

Fire strategy

4.9 The isolation suite is intended to be built as a single fire compartment. The positive pressure in the lobby will deter smoke originating in the corridor from entering the room. Smoke from a fire in the room will be contained within the suite and extracted via the en-suite extract. Because of this the ventilation system serving the isolation facility should be kept running in the event of a fire.

4.10 Ductwork thickness should be such that ducts can be considered an extension of the isolation suite. Fire dampers, where the ducts penetrate walls and floors, will not then be required.

4.11 A motorised smoke/fire damper should be fitted at the discharge of the supply air handling unit (AHU). The damper should close in the event of an AHU or intake fire under the control of a smoke detector mounted in the AHU.

Extract ventilation

4.12 An extract terminal should be fitted at high level in the en-suite room. An additional terminal may be fitted at low level adjacent to the bedhead in the bedroom.

4.13 A transfer grille should be fitted at low level in the door between the bedroom and en-suite room.

4.14 The extract duct should be fitted with a spectacle plate or gas-tight damper so that the system can be sealed to allow the isolation suite to be disinfected. The plate or damper should be fitted at the inlet of the extract fan. This will also permit isolation of the extract fan for service and maintenance.

4.15 The extract fan unit should preferably be located outside the building so that all ductwork within the building is under negative pressure. Access and cleaning hatches should only be fitted where absolutely necessary. If fitted they should be of the sealed type and marked with a bio-hazard symbol. If the fan has to be located inside the building it should be as close as practicable to the outside. The extract fan motor should be mounted out of the air stream and should be capable of being changed without withdrawing the impeller or opening up the ductwork. The extract fan should draw its power from the essential electrical system.

4.16 Extract filters will not be required provided that the fan can discharge in a safe location 3000 mm above the building height. If extract filters are fitted they should be in a “safe change housing” outside the building on the suction side of the fan. Extract filters, where fitted, should be of H14 grade. Even if filtered, extract air must not be re-circulated.

4.17 Extract ductwork, the fan and discharge stack must be clearly marked to identify the isolation suite that they serve. Service, maintenance, cleaning and filter change of the system will be subject to a permit to work.

Supply ventilation

4.18 The supply AHU should comply in all respects with the minimum standards set out in HTM 2025. Heating and cooling should be provided, but not humidification. The fire/smoke damper fitted in the discharge from the AHU should close on plant shutdown and/or air flow

failure, sealing the AHU from the distribution ductwork. This will prevent any reverse air flow and permit routine maintenance or system disinfection. The supply fan should draw its power from the essential electrical system.

4.19 The supply AHU and distribution ductwork must be clearly marked to identify the isolation suite that they serve. Access and cleaning hatches should only be fitted where absolutely necessary. They should be of the sealed type and marked with a bio-hazard symbol. Service, maintenance, cleaning and filter change of the system will be subject to a permit to work.

4.20 A G3 pre-filter and final filter should be fitted in the AHU. The lobby air supply terminal should be of a type into which a HEPA filter can be fitted. While it is not envisaged that a HEPA filter will be routinely required, this arrangement will allow for subsequent fitting when appropriate with the least disturbance. A sealable upstream DOP injection test point will be required in the supply duct so that, if a HEPA filter is fitted, it can be challenge tested on installation.

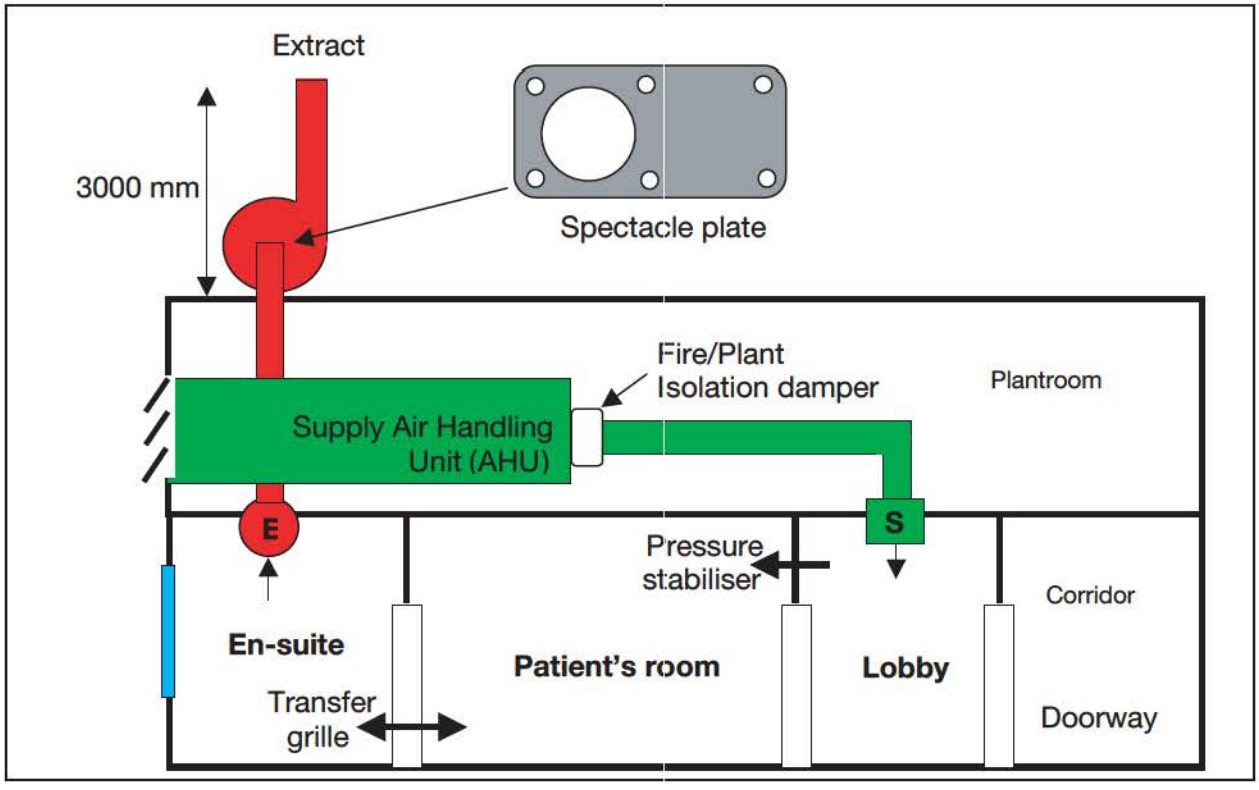
4.21 A pressure stabiliser of the balanced blade type, set to operate at 10 pascals, should be fitted above the door between the lobby and the bedroom. The stabiliser should be visible so that its correct operation can be seen. It should be of a style that will operate silently, and be correctly sized and positioned so that it does not cause a draught that would be uncomfortable for patients.

4.22 A direct reading gauge showing the pressure in the lobby with respect to the corridor should be mounted at eye level on the corridor wall adjacent to the lobby entry door. The gauge and lobby entry door must be clearly marked to identify the isolation suite to which they refer.

Record keeping

4.23 A logbook will be required for each isolation suite. It should contain the following information:

1. A schematic layout of the isolation suite and ventilation system serving it.
2. Information on the ventilation design parameters.
3. A record of the actual ventilation performance at initial validation. (All of the tests set out in Appendix II 'Acceptance testing of isolation suite' should be carried out.)
4. Records of the annual validations. (The parameters set out in Appendix II should be measured.)
5. Records of the lobby pressure, taken by ward staff.
6. Records of any routine service and maintenance activities.
7. Records of any repairs or modifications.
8. A method statement for disinfecting the system.



Isolation suite ventilation system – example layout

4.24 When the suite is taken out of use the logbook should be preserved for at least five years.

Other considerations

4.25 As far as practicable, access to domestic hot and cold water services and their associated thermostatic mixing valves should be via access panels in the lobby or corridor. Every effort should be made to avoid service and maintenance staff having to enter or pass through the bedroom when carrying out routine service and maintenance tasks.

Service and maintenance

4.26 Spectacle plates or gas-tight dampers should be used to seal the system, should the suite and/or its ventilation system require disinfection. A method statement should be prepared detailing the procedure. For further guidance on disinfection refer to 'Biological agents: Managing the risks in the laboratory and healthcare premises' (Advisory Committee on Dangerous Pathogens, forthcoming). All works of service and maintenance should be subject to a permit to work.

Appendix I – Example room layouts

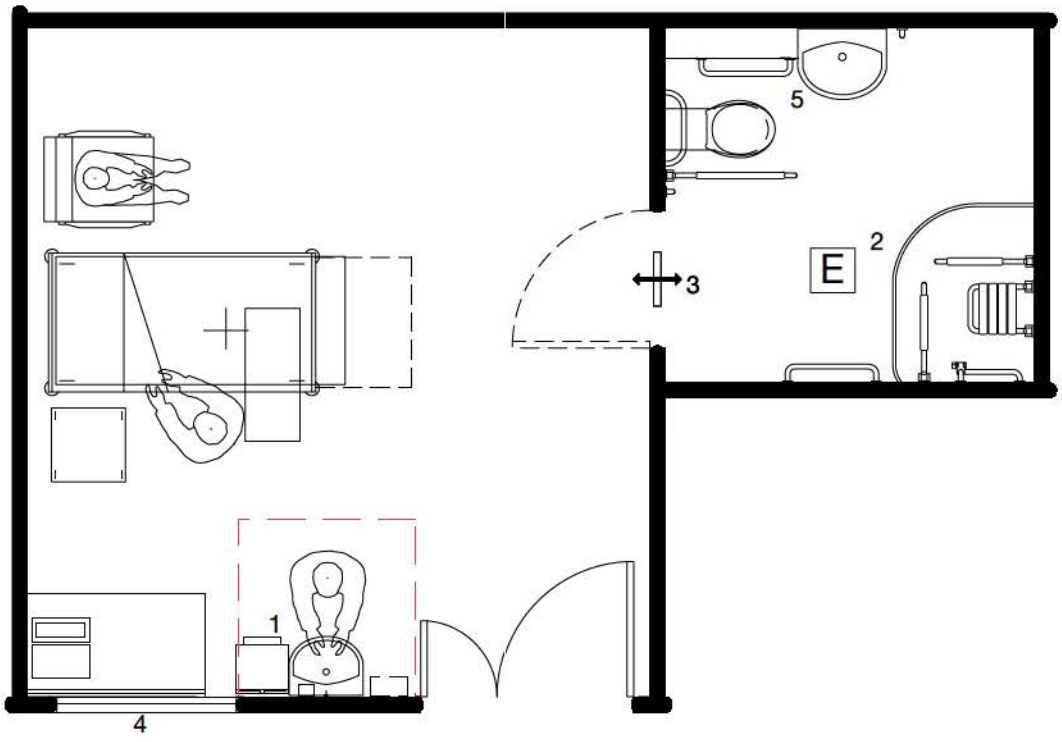
The room layouts in this appendix are examples and are intended as a guide. Other room configurations are possible.

For the latest guidance on space standards refer to HBN 4 – 'In-patient accommodation' (revised schedule available from the Knowledge and Information Portal at http://www.nhsestates.gov.uk).

Use of Single Rooms for Isolation: Key Design Principles

Sheet 1

New build single room with en-suite facilities



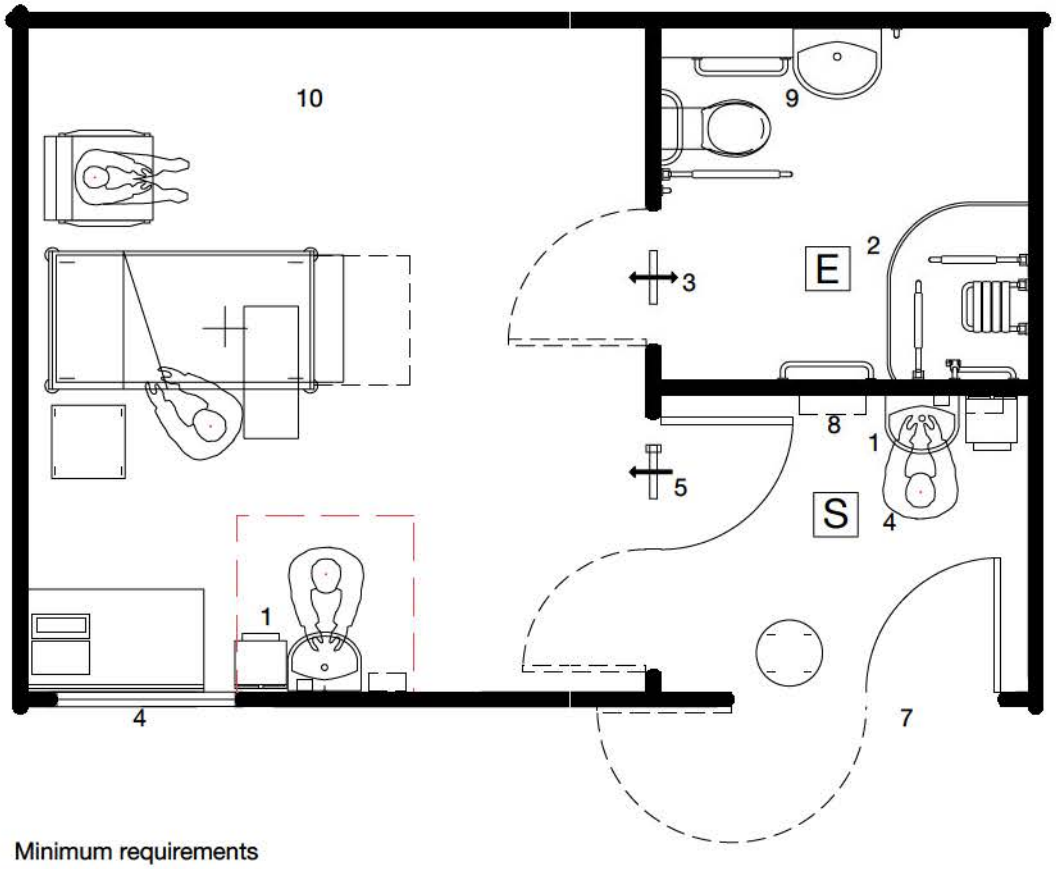
Minimum requirements

1. Clinical hand-wash basin with non-touch, fixed temperature mixer tap
2. Provide suitable extract fan
3. Transfer grille to en-suite door
4. Observation window in corridor wall with integral privacy blinds to allow for staff observation and patient views out
5. En-suite WC to be non-touch flush and wash basin to have single tap with flow and temperature control

Use of Single Rooms for Isolation: Key Design Principles

New build single room with en-suite facilities and lobby

Sheet 2



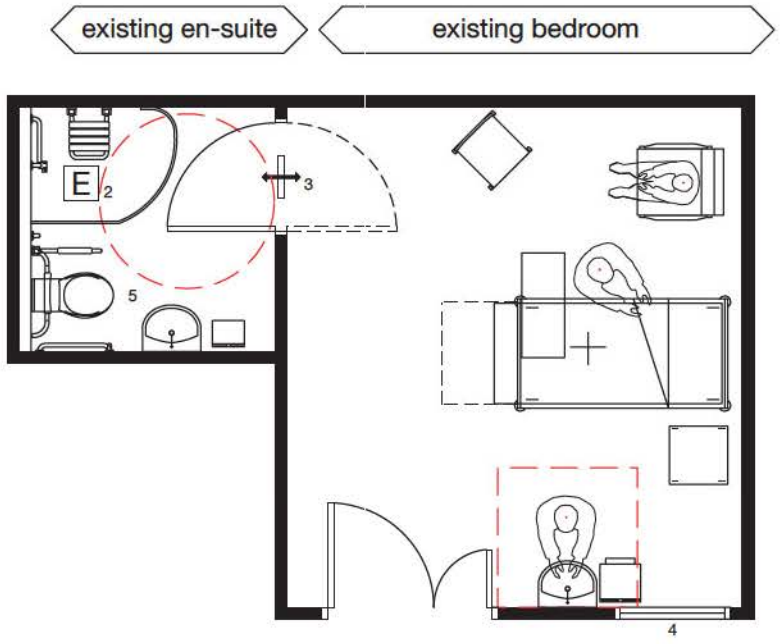
Minimum requirements

1. Clinical hand-wash basin with non-touch, fixed temperature mixer tap
2. Provide suitable extract fan
3. Install transfer grille to en-suite door
4. Supply air
5. Pressure stabiliser
6. Observation window in corridor wall with integral privacy blinds to allow for staff observation and patient views out
7. Double door for personnel and bed access
8. Disposable apron dispenser
9. En-suite WC to be non-touch flush and wash basin to have single tap with flow and temperature control
10. Ceiling to be sealed solid construction, external window to be sealed

Use of Single Rooms for Isolation: Key Design Principles

Sheet 3

Existing single room with en-suite facilities



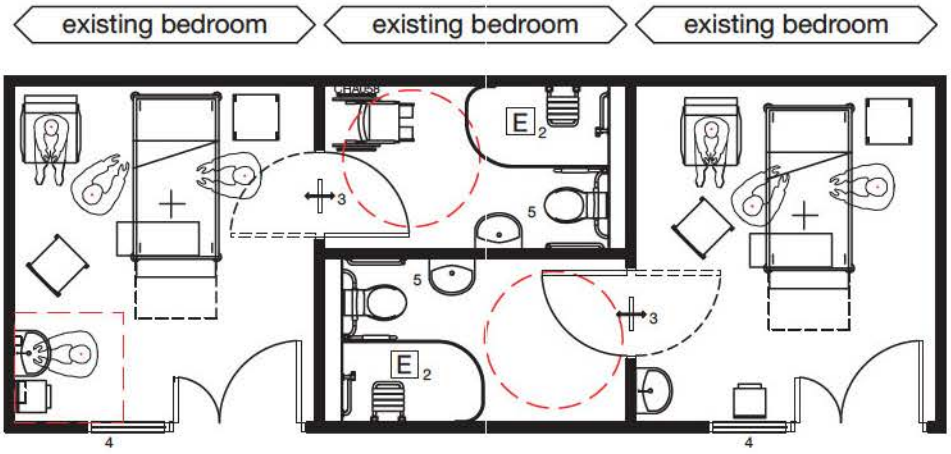
Minimum requirements to upgrade existing facilities

1. Add clinical hand-wash basin with non-touch, fixed temperature mixer tap
2. Upgrade existing extract fan
3. Install transfer grille to en-suite door
4. Observation window in corridor wall with integral privacy blinds to allow for staff observation and patient views out
5. En-suite WC to be non-touch flush and wash basin to have single tap with flow and temperature control

Use of Single Rooms for Isolation: Key Design Principles

Sheet 4

Single rooms without en-suite facility.
Upgrading three existing single rooms to provide two single rooms with en-suite facilities



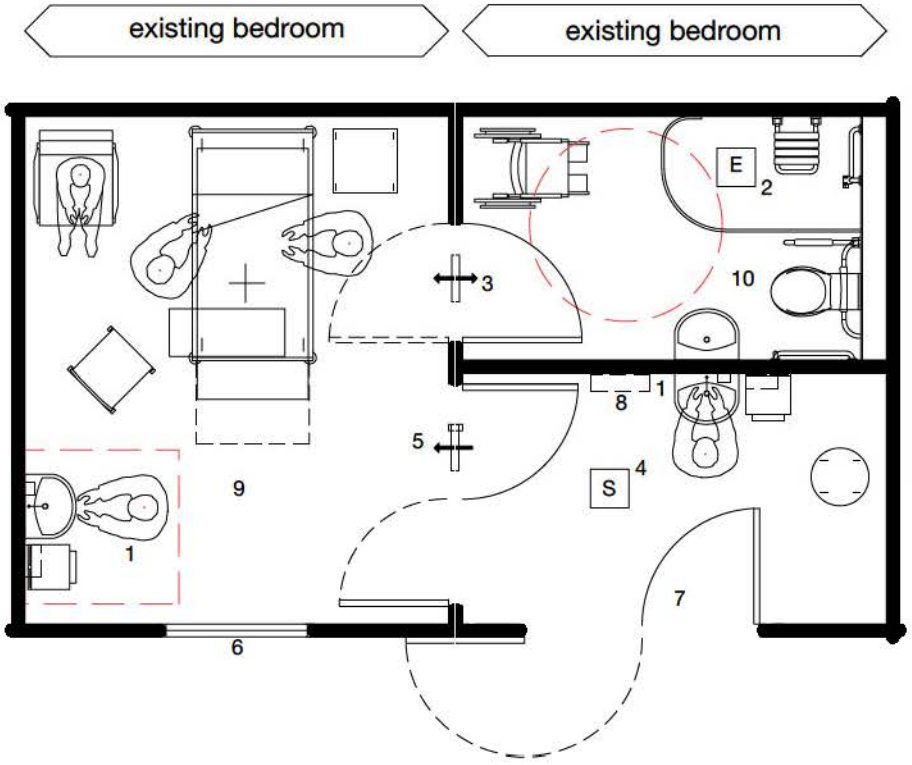
Minimum requirements to upgrade existing facilities

1. Add clinical hand-wash basin with non-touch, fixed temperature mixer tap
2. Provide suitable extract fan
3. Install transfer grille to en-suite door
4. Observation window in corridor wall with integral privacy blinds to allow for staff observation and patient views out
5. En-suite WC to be non-touch flush and wash basin to have single tap with flow and temperature control

Use of Single Rooms for Isolation: Key Design Principles

Sheet 5

Single rooms without en-suite facility.
Upgrading two existing single rooms to provide one single room with en-suite facilities and alternative lobby



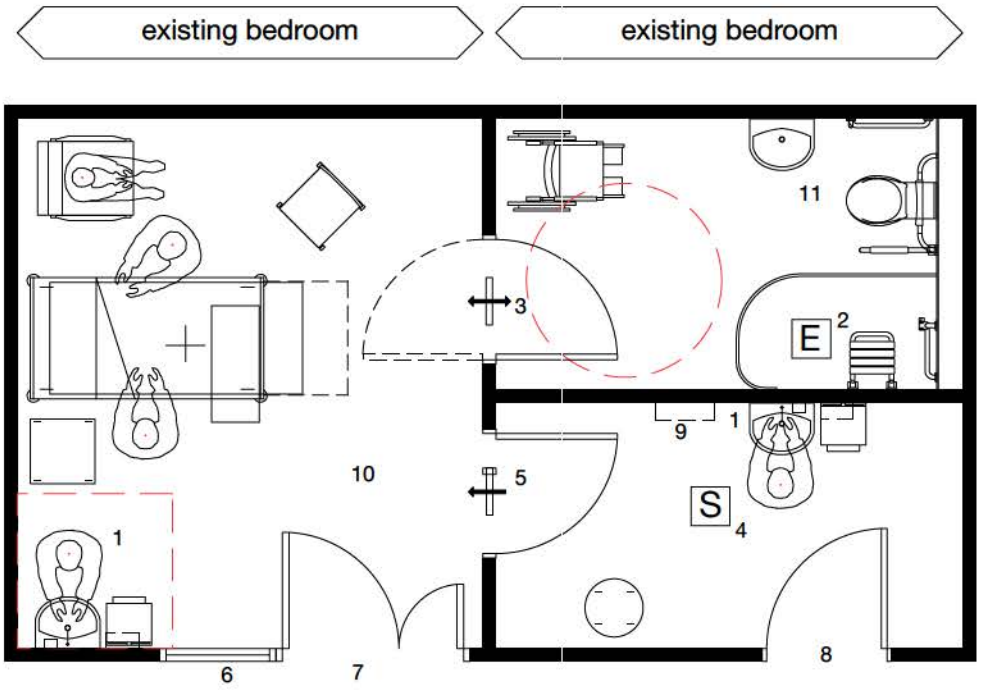
Minimum requirements to upgrade existing facilities

1. Add clinical hand-wash basin with non-touch, fixed temperature mixer tap
2. Provide suitable extract fan
3. Install transfer grille to en-suite door
4. Supply air
5. Pressure stabiliser
6. Observation window in corridor wall with integral privacy blinds to allow staff observation and patients views out
7. Double door for personnel and bed access
8. Disposable apron dispenser
9. Upgrade ceiling to sealed solid construction, external windows to be sealed
10. En-suite WC to be non-touch flush and wash basin to have single tap with flow and temperature control

Use of Single Rooms for Isolation: Key Design Principles

Sheet 6

Single rooms without en-suite facility.
Upgrading two existing single rooms to provide one single room with en-suite facilities and lobby



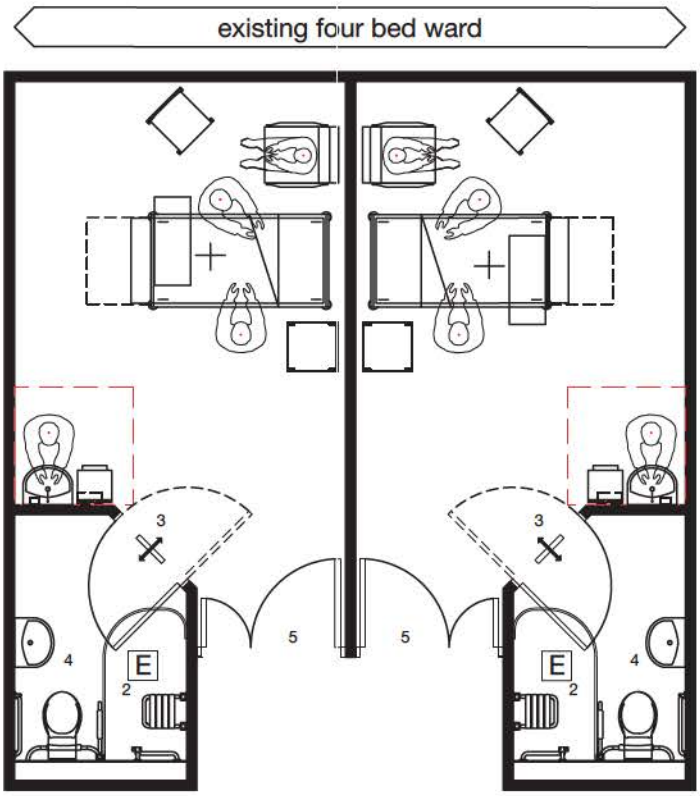
Minimum requirements to upgrade existing facilities

1. Add clinical hand-wash basin with non-touch, fixed temperature mixer tap
2. Provide suitable extract fan
3. Install transfer grille to en-suite door
4. Supply air
5. Pressure stabiliser
6. Observation window in corridor wall with integral privacy blinds to allow for staff observation and patient views out
7. Existing door and a half for bed access only must be kept locked and have seals to minimise air transfer
8. Single door access via lobby
9. Disposable apron dispenser
10. Upgrade ceiling to sealed solid construction, external windows to be sealed
11. En-suite WC to be non-touch flush and wash basin to have single tap with flow and temperature control

Use of Single Rooms for Isolation: Key Design Principles

Upgrading existing four bed ward to provide two single rooms with en-suite facilities

Sheet 7



Minimum requirements

1. Clinical hand-wash basin with non-touch, fixed temperature mixer tap
2. Provide suitable extract fan
3. Transfer grille to en-suite door
4. En-suite WC to be non-touch flush and wash basin to have single tap with flow and temperature control
5. Doors to be fully glazed, with integral privacy blinds, to allow staff observation and patients views out

Appendix II – Acceptance testing of isolation suite

DEFINITIONS

Isolation suite

Includes the entry lobby, patient's room, en-suite facility and any storage or other area directly accessible from the patient's or en-suite room.

Isolation suite envelope

The isolation room suite bounded by a solid floor, solid ceiling and full-height walls that separate it from any other adjoining space or the outside.

Validation – Isolation suite air permeability (leakage rate)

The suite will be considered fit for purpose if at a test pressure of +20 and –20 Pascals it has an average leakage rate of not more than 1 l/s of air per 1 m^3 of envelope volume. The method of testing is set out below.

(Rationale: To ensure effective isolation, it is important that air leakage to or from adjacent areas is kept to a minimum. Construction gaps should be minimised and service penetrations sealed before the suite is tested. The test pressures are significantly more than would be achieved under a ventilation fault condition within the isolation suite. When in operation, the patient's room and en-suite are designed to be at a neutral or slightly negative pressure so the actual leakage between adjoining spaces should be insignificant.)

VALIDATION

Filtration test standards

General and fine filter grades to BS EN 779:2002 should be visually inspected to ensure that they are free from tears or other damage at the time of installation. They should be a good fit in their housing, with no obvious gaps that could allow air bypass.

High Efficiency Particulate Air (HEPA) filters, where fitted, should be certified by their manufacturer for conformity to BS EN 1822:2000. When installed, their performance should be checked with a particle counter using the method set out in BS EN 1822:2000 for *in situ* aerosol testing.

Air permeability – Tests method

1. Establish the volume of the isolation suite envelope as defined above.
2. Turn off the suite supply and extract ventilation systems and those serving adjoining spaces. *(Rationale: All adjoining spaces need to be at atmospheric pressure in order to establish the true leakage rate.)*
3. Seal all supply and extract terminals.
4. Wedge all internal doors open.
5. Fit a temporary board seal and test fan in the lobby to corridor doorway.
6. Run the fan to maintain a positive test pressure of 20 Pascal for at least two minutes.
7. Measure the air flow rate of the fan.
8. Reverse the fan and run it to maintain a negative test pressure of 20 Pascal for at least two minutes.
9. Measure the air flow rate of the fan.
10. Average the two air flow readings obtained.
11. Calculate the leakage rate in l/s of air per m^3 of envelope volume. If the isolation suite envelope is correctly sealed the readings should be within 5% of each other.

Further details of the test method are contained in 'Testing buildings for air leakage', CIBSE, TM23, 2000.

Close all internal doors and, using the test fan, check that the pressure stabiliser opens at 10 Pascal and that it will carry the design air flow without flutter.

These tests should be carried out at initial commissioning and as necessary thereafter following works of refurbishment or when there is any doubt as to the actual performance standard of the suite.

System operating standard

The suite will be considered fit for purpose if, with the ventilation system operating and all doors closed, the following parameters are achieved:

- a positive pressure of between 8 and 12 pascals between the entry lobby and the corridor;
- the patient's room has an air change rate of at least 10 per hour;
- the en-suite room is at a negative pressure with respect to the patient's room;
- a failure of either the supply or extract fan will be indicated at a designated nurse station and the estates department.

The suite should be tested following initial commissioning and thereafter re-tested at least annually for conformity with this operating standard.

References

ACTS AND REGULATIONS

Control of Substances Hazardous to Health (COSHH) Regulations 1999, SI 1999 No 2380. The Stationery Office.
http://www.legislation.hmso.gov.uk/si/si2000/20002380.htm

The Building Regulations 2000, SI 2000 No 2531. The Stationery Office.
http://www.legislation.hmso.gov.uk/si/si2000/20002531.htm

Access to and use of buildings (Approved document M). Office of the Deputy Prime Minister, The Stationery Office, 2003.

BRITISH STANDARDS

BS 8300: 2001 Design of buildings and their approaches to meet the needs of disabled people – Code of practice. British Standards Institute, London.

BS EN 779:2002 Particulate air filters for general ventilation. Determination of the filtration performance.

BS EN 1822-4:2000 High efficiency air filters (HEPA and ULPA). Determining leakage of filter element (scan method).

BS EN 1822-5:2000 High efficiency air filters (HEPA and ULPA). Determining the efficiency of filter element.

NHS ESTATES

Health Facilities Note (HFN) 30 – 'Infection control in the built environment: design and planning'. NHS Estates, The Stationery Office, 2002.

Health Building Note (HBN) 4 – 'In-patient accommodation: options for choice'. NHS Estates, The Stationery Office, 1997 (new edition in preparation).

HTM 2025 – 'Ventilation in healthcare premises'. NHS Estates, The Stationery Office (new edition forthcoming 2005).

HTM 2027 – 'Hot and cold water supply, storage and mains services'. NHS Estates, The Stationery Office, 1995.

HTM 2040 – 'The control of legionellae in healthcare premises: a code of practice'. NHS Estates, The Stationery Office, 1993.

Revised schedules of accommodation. NHS Estates, March 2001.
http://www.nhsestates.gov.uk

NHS Cleaning Manual. NHS Estates, 2004.
http://www.nhsestates.gov.uk

OTHER PUBLICATIONS

The management and control of hospital acquired infection in acute NHS Trusts in England. National Audit Office, 2000.

Winning Ways: Working together to reduce healthcare associated infection in England. Department of Health, 2003.

Biological agents: Managing the risks in the laboratory and healthcare premises. Advisory Committee on Dangerous Pathogens, The Stationery Office (forthcoming).

Testing buildings for air leakage. CIBSE, TM23, 2000.

USEFUL WEBSITES

Hospital Infection Society
http://www.his.org.uk

Infection Control Nurses' Association
http://www.icna.co.uk

Health Protection Agency
http://www.hpa.org.uk

http://www.hcsu.org.uk

Royal College of Nursing
http://www.rcn.org.uk

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SHTM 03-01
Ventilation for healthcare premises
Part A – Design and validation

Health Facilities Scotland
Engineering and Environment

March 2009

Contents

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Acknowledgements

Malcolm Thomas – Consulting Engineer – Lead Author

Principal contributors

Craig MacIntosh – Principal Clinical Scientist – Wirral Hospitals NHS Trust

Andy McGrath – BSRIA Instrument Solutions

Helen & Philip Sturdy – DSSR Consulting Engineers

Richard Gatley – Apreco

Russell Pitman – Henderson Green consultancy

Kevin Reynolds – Deputy Head of Estates – Sandwell and West Birmingham NHS Trust

Ian Fraser – Department of Health

Main Steering Group and Working Groups comprising representatives from:

Department of Health

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BSI

Faber Maunsell consultancy

Couch Perry Wilkes consultancy

DSSR Consulting Engineers

Howarth Airtech

Medical Air Technology/Thermo Electric

BPG Medical

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Volkes SPX

Weiss Kilmatechnik

Sound Research Laboratories

NHS Security Management Service

Pennine Acute NHS Trust

Hospital Infection Society (HIS)

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HEVAC – Air-handling Unit Manufactures Group

Preface

About Scottish Health Technical Memoranda

Engineering Scottish Health Technical Memoranda (SHTMs) give comprehensive advice and guidance on the design, installation and operation of specialised building and engineering technology used in the delivery of healthcare.

The focus of Scottish Health Technical Memorandum guidance remains on healthcare-specific elements of standards, policies and up-to-date established best practice. They are applicable to new and existing sites, and are for use at various stages during the whole building lifecycle.

Healthcare providers have a duty of care to ensure that appropriate engineering governance arrangements are in place and are managed effectively. The Engineering Scottish Health Technical Memorandum series provides best practice engineering standards and policy to enable management of this duty of care.

It is not the intention within this suite of documents to repeat unnecessarily international or European standards, industry standards or UK Government legislation. Where appropriate, these will be referenced.

Healthcare-specific technical engineering guidance is a vital tool in the safe and efficient operation of healthcare facilities. Scottish Health Technical Memorandum guidance is the main source of specific healthcare-related guidance for estates and facilities professionals.

The core suite of nine subject areas provides access to guidance which:

- is more streamlined and accessible;
- encapsulates the latest standards and best practice in healthcare engineering;
- provides a structured reference for healthcare engineering.

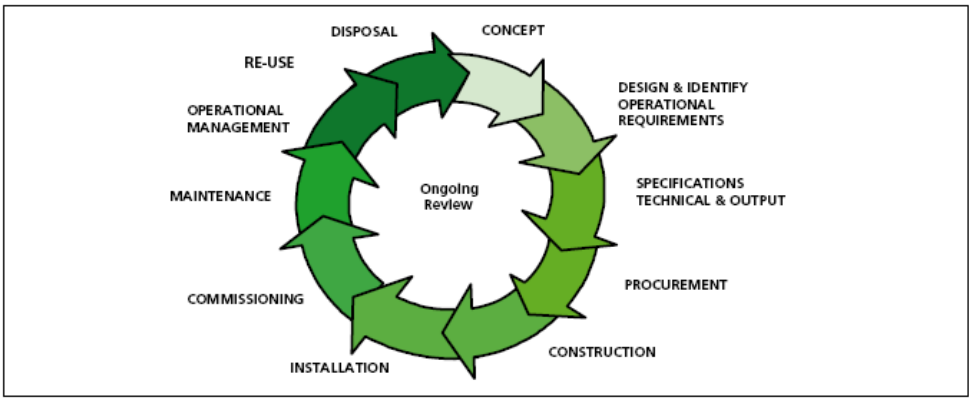

Figure 1: Healthcare building lifecycle

Structure of the Health Technical Memorandum suite

The series of engineering-specific guidance contains a suite of nine core subjects:

Scottish Health Technical Memorandum 00 Policies and principles (applicable to all Health Technical Memoranda in this series).

Scottish Health Technical Memorandum 01 Decontamination.

Scottish Health Technical Memorandum 02 Medical gases.

Scottish Health Technical Memorandum 03 Heating and ventilation systems.

Scottish Health Technical Memorandum 04 Water systems.

Scottish Health Technical Memorandum 05 Reserved for future use.

Scottish Health Technical Memorandum 06 Electrical services.

Scottish Health Technical Memorandum 07 Environment and sustainability.

Scottish Health Technical Memorandum 08 Specialist services.

Some subject areas may be further developed into topics shown as -01, -02 etc and further referenced into Parts A, B etc.

Example: Scottish Health Technical Memorandum 06-02 Part A will represent: Electrical Services – Electrical safety guidance for low voltage systems.

In a similar way Scottish Health Technical Memorandum 07-02 will simply represent:

Environment and Sustainability – EnCO_2de.

All Health Technical Memoranda are supported by the initial document Health Technical Memorandum 00 which embraces the management and operational policies from previous documents and explores risk management issues.

Some variation in style and structure is reflected by the topic and approach of the different review working groups.

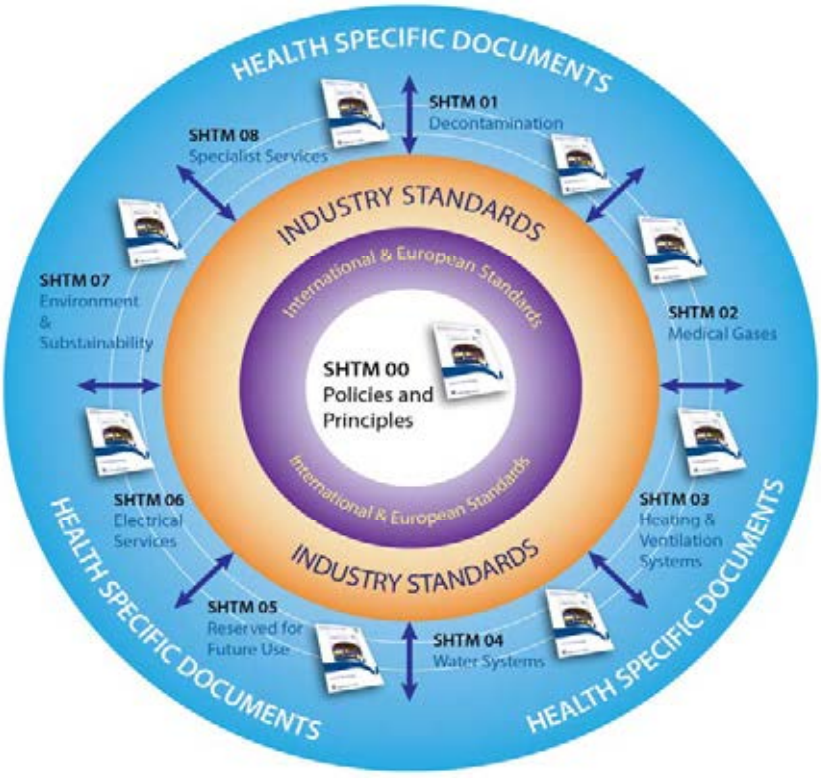

Figure 2: Engineering guidance

1.0 Introduction

1.1 Ventilation is used extensively in healthcare premises for primary patient treatment in operating departments, high dependency units and isolation facilities. It is also installed to ensure compliance with quality assurance of processed items in pharmacy and sterile supply departments and to protect staff from harmful organisms and toxic substances, for example, in laboratories.

1.2 This edition of Scottish Health Technical Memorandum 03 'Ventilation in healthcare premises' is published in two sections. It is equally applicable to both new and existing sites. It gives comprehensive advice and guidance to healthcare management, design engineers, estate managers and operations managers on the legal requirements, design implications, maintenance and operation of general and specialised ventilation in all types of healthcare premises.

1.3 Current statutory legislation requires both 'management' and 'staff' to be aware of their collective responsibility.

1.4 'Ventilation' is also provided in healthcare premises for the comfort of the occupants of buildings. More specialised ventilation will also provide comfort but its prime function will be to control closely the environment and air movement of the space that it serves in order to contain, control and reduce hazards to patients and staff from airborne contaminants, dust and harmful micro-organisms.

1.5 Ventilation systems in themselves present little danger to patients or staff; however, they do possess the ability to transmit hazards arising from other sources to large numbers of people. The danger may not become apparent until many patients and staff have been affected.

1.6 The sophistication of ventilation systems in healthcare premises is increasing. Patients and staff have a right to expect that it will be designed, installed, operated and maintained to standards that will enable it to fulfil its desired functions reliably and safely.

1.7 The Health and Safety at Work etc Act 1974 (HSW Act 1974) is the core legislation that applies to ventilation installations. As these installations are intended to prevent contamination, control closely the environment, dilute contaminants or contain hazards, their very presence indicates that risks to health have been identified.

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Statutory Requirements

1.8 The Control of Substances Hazardous to Health (COSHH) regulations place upon management an obligation to ensure that suitable measures are in place to protect their staff and others affected by the work activity. These methods

may include both safe systems of work and the provision of a specialist ventilation system. In laboratories the requirements are often met by the provision of fume cupboards and safety cabinets.

1.9 The existing requirements to provide ventilation, implicit under HSW Act 1974 and COSHH, have been made explicit by the Management of Health and Safety at Work Regulations 1999, the Workplace (Health, Safety and Welfare) Regulations 1992 and the Provision and Use of Work Equipment Regulations 1998, all issued as a result of European Directives.

1.10 Where specialist ventilation plant is provided as part of the protection measures there is a statutory requirement that it be correctly designed, installed, commissioned, operated and maintained. The local exhaust ventilation (LEV) section of the COSHH regulations requires that the plant be inspected and tested at least every 14 months by an independent organisation and that management maintain comprehensive records of its performance, repair and maintenance.

1.11 Certain substances have Occupational Exposure Limits (OEL) set out in Guidance Note EH 40 published annually by the Health and Safety Executive. If special ventilation systems are provided in order to achieve these standards they will be subject to the COSHH regulations as above.

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1.12 All ventilation systems should conform to the principles set out in the 'Approved Code of Practice on the Prevention or Control of Legionellosis' published by the Health and Safety Commission and Scottish Health Technical Memorandum SHTM 04-01 – The control of *Legionella*, hygiene, "safe" hot water, cold water and drinking water systems.

1.13 Special ventilation plants installed in laboratories dealing with research, development or testing, whether involving drugs, animals or genetically modified organisms, may be subject to particular legislation with regard to their operation in addition to that mentioned above. Further information is given by the Health and Safety Commission Health Services Advisory Committee in:

- safe working and prevention of infection in clinical laboratories;
- safe working and prevention of infection in clinical laboratories: model rules for staff and visitors;
- safe working and prevention of infection in clinical laboratories in the mortuary and post-mortem room.

1.14 Plants installed in units manufacturing medicinal products to the standards set out in the current European Guide to Good Manufacturing Practice may also be subject to particular legislation with regard to their operation in addition to that mentioned above.

1.15 Records should be kept of equipment design and commissioning information. The Health and Safety Executive, Medicines Inspectorate and other interested bodies have a statutory right to inspect them at any time. All records should be kept for at least five years.

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Deleted: , operational management, monitoring and maintenance of the equipment

1.16 The fire regulations require that if ventilation ductwork penetrates the fabric of a building it should be designed and installed so as to contain the spread of fire.

1.17 Increased health risks to patients will occur if the more specialised ventilation systems installed to supply high quality air to operating departments do not achieve and maintain the required standards. The link between post-operative infection and theatre air quality has been well established. Plants serving conventional operating departments, for instance, will be required to ensure the separation of areas within the suite by maintaining a specific direction of air flow between rooms, even when doors are opened. They will also maintain the selected operating department environmental conditions regardless of changes in the outside air conditions or activities within the space. In addition ultra-clean operating ventilation systems which are designed to provide an effectively particle-free zone around the patient while the operation is in progress, have been shown to reduce significantly post-operative infection in patients undergoing deep wound surgery. Their use for other forms of surgery may well be indicated.

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1.18 Ventilation systems that can be shown to be inappropriate, inadequate or ineffective and that give rise to proven failures can result in a civil suit by the patient against the operators.

1.19 If the plant has been installed to dilute, extract or contain harmful substances, its failure may expose people to unacceptable levels of hazard. Proven failures can give rise to a civil suit against the designers and operators by the individuals who have been affected. This would be in addition to the actions brought as a result of breaching the statutory requirements.

Deleted: contamination, again without their becoming immediately aware of it.

1.20 There is a statutory requirement to provide ventilation in all enclosed workspaces. It may be provided by either natural or mechanical means. The following are some of the factors that determine the ventilation requirements of a workspace:

Deleted: Ventilation is essential in all occupied premises. This

Deleted: department or area:

- human habitation (minimum fresh air requirement);

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- the activities of the department, that is, extraction of odours, aerosols, gases, vapours, fumes and dust – some of which may be toxic, infectious, corrosive, flammable, or otherwise hazardous (see Control of Substances Hazardous to Health (COSHH) regulations;
- dilution and control of airborne pathogenic material;
- thermal comfort;
- the removal of heat generated by equipment (e.g. catering, wash-up, sterilising areas, electrical switch rooms, Uninterruptible Power Supply (UPS) cupboards and some laboratory areas);

Deleted: (for example in

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- the reduction of the effects of solar heat gains where other forms of reducing the solar effect is not available or practical, i.e. solar blinds;
- the reduction of excessive moisture levels to prevent condensation (for example Hydrotherapy pools);

- combustion requirements for fuel burning appliances (see BS5376, BS5410 and BS5440);
- 'make-up' supply air where local exhaust ventilation (LEV) etc is installed.

Mechanical ventilation systems are expensive in terms of capital and running costs, and planning solutions should be sought which take advantage of natural ventilation either where the use of the area in question is not critical to airflow patterns or pressures, or where backup systems are available when natural ventilation cannot be achieved.

1.21 When new ventilation systems are accepted for use, full information as to their designed mode of operation together with recommended maintenance procedures should be provided as part of the handover procedure.

Requirement	Reason	Application
Statutory	Health and Safety at Work Act	Operating department Laboratories Pharmacy
	COSHH regulations	Areas containing identified biological or chemical hazards Areas containing oxygen displacing gases
	Local Exhaust Ventilation (LEV)	Enclosed work-spaces Workshops
Functional	Comfort	Situations where the quality of the environment for staff and patients is critical to their general performance and well-being
Clinical	Post-operative infection reduction	Operating suites used for general surgery, casualty, obstetrics/gynaecological and maternity procedures
	Reduction of deep wound sepsis	Ultra-clean operating suites for transplant, deep wound surgery, hip replacement, bone grafting and bone marrow transplant procedures
	Isolation from contact with bio hazards	Isolation rooms for neutropeanic patients Isolation rooms for infective patients

Table 1 – Reasons for providing ventilation

Functional Overview – Terms in use

1.22 The terms 'ventilation' and 'air-conditioning' are often incorrectly used to describe the same equipment. A general explanation of the terms is given below.

Ventilation

1.23 Ventilation is a means of removing and replacing the air in a space. In its simplest form this may be achieved by opening windows and doors. Mechanical ventilation systems provide a more controllable method. Basic systems consist of a fan and either collection, (extraction) or distribution (supply) ductwork. More complex systems may include the ability to heat and filter the air passing through them. Ventilating equipment may be required in order to remove smells, dilute contaminants and ensure that a supply of 'fresh' air enters a space.

Air-Conditioning and Mechanical Cooling

1.24 Air-conditioning is the ability to heat, cool, dehumidify and filter air. For full air-conditioning, humidification may also be provided. This means that the climate within a space being supplied by an air-conditioning plant can be maintained at a specific level regardless of changes in the outside air conditions or the activities within the space. Mechanical cooling may be provided where close control of 'comfort conditions' within a space is required but humidity control is not needed.

Special Ventilation

1.25 In healthcare premises, certain activities will necessitate the provision of ventilation equipment with additional special features in order to achieve and maintain specific conditions. These may be needed in order to assist with the treatment of patients or maintain the health and safety of staff. The precise reason for providing special ventilation will depend upon the intended application. The list below indicates some of the more typical reasons:

- to remove, contain or dilute specific contaminants and fumes;
- to ensure the isolation of one space from another;
- to preserve a desired air flow path from a 'clean' to a 'less clean' area;
- to provide control of the cleanliness of a space;
- to provide 'close' control of temperature;
- to provide 'close' control of humidity.

1.26 The following departments will usually have specialist ventilation requirements, either for a single room or throughout a suite of rooms:

- operating department;
- laser surgery unit;
- intensive treatment unit;
- infectious diseases isolation unit;
- manufacturing pharmacy;

- specialist imaging, X-ray and scanning unit;
- pathology containment laboratories;
- mortuary and dissection suite;
- research laboratory;
- sterilising and disinfecting unit (SDU);
- endoscopy unit;
- renal dialysis suite;
- ultrasound facilities;
- audiology room.

Deleted: laboratories and associated animal houses;

1.27 Ventilation may be provided in a wide variety of ways. These will include:

- extensive purpose-built air-conditioning units housed in their own plant rooms;
- proprietary 'packaged' systems often sited outside on a roof or;
- wall-mounted electric fans located at the point of use.

1.28 A fixed volume of air may be supplied, often expressed in terms of the resulting number of air changes per hour (ac/h) within the space being ventilated. It may also be expressed in terms of litres/second/person. Alternatively the volume of air supplied may be varied in order to maintain a specific pressure relationship between the area supplied and other surrounding areas. In some situations a combination of both methods may be adopted.

1.29 Modern plants are fitted with the means to recover energy from the extract air where this can be justified without causing contamination of the incoming supply air.

1.30 Ultra-clean systems use the same basic plant and equipment as standard air-conditioning but are in addition fitted with a terminal device that supplies the air in a uni-directional manner to the working area. Their standard of filtration will be capable of delivering air with a very low particle count to the space that they serve.

Local exhaust ventilation

1.31 Local exhaust ventilation (LEV) is a term used to describe systems installed to prevent hazardous substances from entering the general atmosphere of the room in which they are being used. Their primary function is to protect staff from the effects of their work activity.

1.32 Simple LEV systems comprise a capture hood, extract ductwork and fan. These are used to contain industrial types of hazard such as fumes from welding processes, gas discharges from standby battery banks and dust from woodworking machinery. The vapour given off when large quantities of

chemicals are decanted into ready-use containers and fumes from X-ray film processing units are further examples of chemical hazards often controlled by LEV systems.

1.33 In laboratories, pharmaceutical manufacturing facilities and operating suites, LEV systems usually take the form of semi-open fronted cabinets within which the hazardous substance is manipulated. These cabinets either have their own filtered air supply or are fed with air from the room. The air extracted from the cabinet is passed through a high-efficiency filter before being discharged either to the atmosphere or back into the room. Microbiological safety cabinets, laboratory fume cupboards, cytotoxic drug cabinets and fixed or mobile disinfection enclosures are all examples of this type of facility.

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1.34 Mortuaries and dissection suites may have LEV systems incorporated within the dissection table, specimen bench and bone saw.

Management action

1.35 The guidance contained in this SHTM should be applied in full to new installations and major refurbishments of existing installations.

1.36 Ventilation will need to be provided:

- as a requirement for patient care;
- in order to fulfil a statutory duty.

1.37 In assessing the need for more specialist ventilation and the standards desired for patient care, managers will need to be guided by their medical colleagues and by information published by Health Facilities Scotland.

1.38 The statutory need for ventilation falls into two categories:

a. in the first, the need for specialist ventilation and the standards to be adopted are clearly set out in specific pieces of legislation. An excellent example of this is the current legislation surrounding the manufacture of medicinal products in the European Community. The managers of the departments affected by this type of legislative requirement should be aware of their needs and be able to advise on the standards to be achieved;

b. the second type of statutory requirement arises due to the interpretation of both the Health and Safety at Work etc Act and the Control of Substances Hazardous to Health (COSHH) regulations. The person tasked with conducting COSHH assessments will be able to advise as to the need for, and standard of, ventilation in each particular case.

Design and Validation process

1.39 It is essential that when undertaking the design of a specialised ventilation system that the project be considered as a whole. The process model set out below should ensure that all relevant factors are considered.

Design and Validation process model

Step	Question	Design statement and information required	Comment
1	Why is the system required?	Healthcare applications Statutory elements Non healthcare applications	
2	What is the required system performance?	Room air flow pattern Air change rate Differential pressures Air quality Room air condition Noise limits	
3	What are the constraints on the distribution system?	Location, Size, Materials Dampers, Access, Insulation Fire considerations Room terminals	
4	What are the minimum requirements for the AHU(s)?	Intake / Discharge positions *Legionella*, Health and Safety Access, Fire, Electrical safety Leaks, Insulation, Cleanliness Filtration, Drainage	
5	What control functions are required?	User control requirements Estates control functions Energy management Environmental conditions Control sequence logic Run, Set back, Off philosophy	
6	How will the system performance be validated?	Validation methodology Instruments used Design information required [*Design air flow rates* *Design air velocities* *Pressure differentials* *Noise levels* *Air quality* *Installation standard*]	
7	The system will only be acceptable to the client if at the time of validation it is considered fit for purpose and will only require routine maintenance in order to remain so for its projected life.		
8	Handover to client	Basic design information Commissioning results Validation report	

Use and function of typical equipment used in ventilation plant

1.40 Typical equipment used in ventilation systems is listed below together with a brief description of both function and use.

General

1.41 The equipment built into the ventilation system and its ductwork should be of a type that will neither cause nor sustain combustion. No materials that could sustain biological activity should be used in the construction or assembly of the system.

Air Intake

1.42 An uncontaminated air supply to the system is essential. In order to achieve this, the air intake will be positioned so that air discharged from extract systems or other dubious sources cannot be drawn in. Exhaust fumes from vehicles can present particular problems. The area surrounding the intake will need to be kept clean and free of vegetation and waste material in order to reduce the possibility of bio-hazards or fire. The intake itself will be protected by a louvre and mesh screen to prevent rainwater, vermin and insects etc from entering the system.

Deleted: louvre

Damper

1.43 Several types may be fitted:

- automatic dampers fitted immediately behind the air intake and extract louvres. They will automatically close when the system is shut down in order to prevent an uncontrolled circulation of air;
- balancing dampers are fitted into each branch of the air distribution ductwork system so that the design air flow rate can be set during the commissioning process;
- where ductwork passes through a fire compartment wall, ceiling or floor a fire and/or smoke damper may be required;
- plant isolating dampers are fitted so that the main plant can be isolated from its air distribution duct system. They are manually operated and enable cleaning and maintenance of the air-conditioning equipment to be carried out.

Ducting

1.44 The means by which air is conveyed from the intake to its point of use. Ducting is usually constructed of galvanised steel and will normally be insulated to reduce noise and conserve energy. Ducts can also be formed in concrete, brickwork, stainless steel or plastic and may be rigid or flexible.

Fan

1.45 A series of rotating blades that move the air in the direction required. Fans are usually powered by electric motors either directly connected to them or driven through belts and pulleys. A fan may be arranged either to force air into or draw air from a ductwork system.

Attenuator/silencer

1.46 A device that will contain and absorb the noise emitted by a fan. They may be required to reduce disturbance caused by noise breaking out through the air intake and also noise transmitted along the ductwork to the conditioned space.

Filter

1.47 A filter consists of a labyrinth of fibrous material contained in a frame. It is designed to capture and hold particles being carried in the airstream. Because of the size range and number of particles that exist in air no filter can remove them all. The purpose of filtration is to reduce their number and size range to an acceptable level. Filters of progressively higher grades are fitted through the ventilation system:

- primary filters (coarse) are designed to collect the larger particles and are intended to keep the air-conditioning plant clean;
- secondary filters (fine) will remove the staining particles from air and keep the conditioned space visibly clean;
- high efficiency particulate air filters (HEPA/absolute) will remove virtually all particles from air. These may be required in order to reduce contamination in the working area either biologically or in terms of particle count.

Filters may be fitted to extract systems to protect energy recovery devices. They may also be fitted to remove biological, radiation or chemical hazards and if so, are often contained in a 'safe change' facility in order to protect those carrying out maintenance.

Activated carbon filters will reduce odours in extracted or recirculated air.

Heater battery/heater coils

1.48 A series of heater batteries or heating coils with or without fins through which steam or hot water is circulated. Heat is given up to the air passing over the battery thus increasing its temperature. Heating is usually carried out in stages, the final battery being controlled by the end user. Small batteries may be electric.

Humidifier

1.49 A device for increasing the humidity of air by adding moisture. For ventilation in healthcare premises this is normally achieved by releasing 'clean' steam into an air supply duct. The steam will be completely absorbed into the air, increasing its humidity. The level of humidity may be preset or controlled by the end user.

Cooler battery/cooling coil

1.50 A series of finned coils mounted in the air supply duct. Either chilled water or refrigerant is circulated through the coils causing heat to be removed from the air. This will reduce its temperature and may also condense moisture out of the air. As free moisture in a duct can be a source of contamination the coil will be fitted with an eliminator and drainage system.

Eliminator

1.51 A device for catching and removing water droplets from an air stream. It may form part of a cooling coil or be a separate device.

Drainage system

1.52 A means of removing water from ductwork and disposing of it safely. Typically it will consist of a tray mounted in the duct to catch moisture, a glass water seal trap, continuously falling drainage pipework and an air break in the drain run to prevent waste water returning and contaminating the duct.

Access doors and observation ports

1.53 Doors and removable panels providing access for routine maintenance and cleaning. The doors should be fitted with glazed ports and suitable lighting provided so that the correct operation of devices such as cooling coils, humidifiers and filters can be easily observed without needing to switch off the plant.

Energy Recovery

1.54 Many plants are fitted with the means to recover energy from the extract air without causing contamination of the incoming supply air. These devices will be fitted with a drainage system and may incorporate an eliminator. Several types of energy recovery systems are available.

1.55 Precise definitions of ventilation and air-conditioning terms are given in the CIBSE Guide.

Typical plant

1.56 The layout of a typical plant that conforms to the requirements for healthcare applications is shown in Figure 3 below. It contains most of the equipment described above.

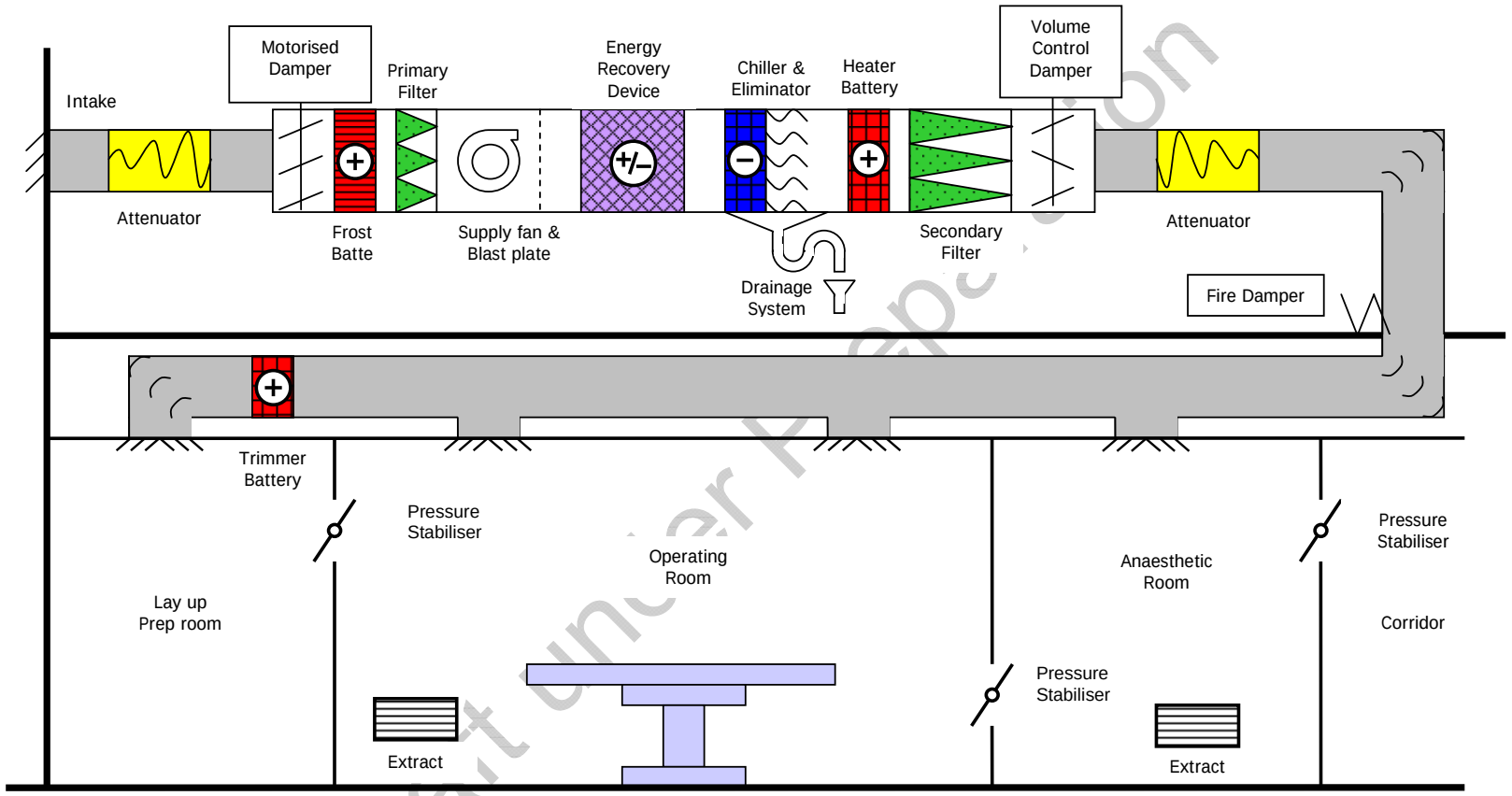

Figure 3: Example of a typical operating theatre ventilation system

2.0 Provision of ventilation in healthcare buildings

2.1 It is acknowledged that planning constraints imposed by the building shape and/or functional relationships of specific areas will invariably result in some measure of deep planning thus reducing the opportunity for natural ventilation. However, ventilation costs can be minimised by ensuring that where practicable, core areas are reserved for rooms that have a functional requirement for mechanical ventilation. Examples are sanitary facilities, dirty utilities and those rooms where clinical or functional requirements have specific environmental needs; and where for reasons of privacy, absence of solar gain etc., windowless accommodation is acceptable. Other spaces appropriate to core areas are those which have only transient occupation and therefore require little or no mechanical ventilation, for example circulation and storage areas.

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Natural ventilation

2.2 Natural ventilation is usually created by the effects of wind pressure. It will also occur if there is a temperature difference between the inside and the outside of the building. The thermo-convective effect frequently predominates when the wind speed is low and will be enhanced if there is a difference in height between inlet and outlet openings. Ventilation induced by wind pressures can induce high air change rates through a building provided air is allowed to move freely within the space from the windward to the leeward side.

2.3 As the motivating influences of natural ventilation are variable, it is almost impossible to maintain consistent flow rates and ensure that minimum ventilation rates will be achieved at all times. This variability is normally acceptable for general areas including office accommodation, general wards, staff areas, libraries rooms, dining rooms and similar areas which should, where possible, be provided with opening windows of a design that facilitates natural ventilation.

2.4 Current guidance restricts the amount windows can be opened for safety reasons and as many designs are top hung, their ability to permit natural ventilation is limited. It may therefore be necessary to provide dedicated ventilation openings in the fabric of the building to allow a sufficient natural flow of air into and out of the space.

2.5 In all cases, excessive heat gain, indoor air quality requirements or external noise may limit or preclude the use of natural ventilation.

Deleted: General extract

Extract ventilation systems

2.6 Separate extract ventilation will be required for sanitary facilities, lavage areas, dirty utilities and in rooms where odorous, but non-toxic fumes are likely, in order to ensure air movement into the space. However, 10 air changes per hour have been found necessary, particularly in geriatric and psychogeriatric

Deleted: 2/2.7 . A general extract system will be required

accommodation. A single fan/motor unit can be suitable for individual rooms, but multi-room systems should be provided with duty and standby fans or motors to meet this need. There is no healthcare requirement to provide a separate foul extract system over and above that required by the building regulations, but this is almost universally provided for control of infection purposes.

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Foul extract ventilation systems¶
2/2.8 A separate extract system will be required for sanitary facilities, lavage areas and dirty utilities, using dual motor/fan extract units with automatic change-over facilities to ensure that these rooms are maintained at negative pressure while the unit is in use.¶

2.7 Toilets should have an extract rate as set out in the building regulations. Where WC's are located in shower and bathroom spaces, the ventilation required for the WC will normally be adequate for the whole space.

Supply only ventilation

2.8 Mechanical supply ventilation will be required in areas where it is important to maintain a positive pressure in order to prevent the ingress of less clean air, e.g. in pharmacy aseptic suites, sterile supply packing rooms, operating theatres and their preparation rooms. (air change rates are given in Table A1 within Appendix 1).

Deleted: clean utilities or operating departments.

Supply and extract ventilation

2.9 Mechanical supply and extract ventilation should be provided in rooms where there is a need to control room pressure in relation to adjacent spaces. ICU, isolation suites and treatment areas are typical applications.

Mechanical or Comfort cooling

2.10 Cooling is very expensive in terms of energy costs and should be provided only where necessary to maintain a comfortable environment for staff and patient, or to ensure satisfactory operation of equipment. The imaging department in particular may require cooling to offset the equipment load.

2.11 Calculations and thermal modelling should be undertaken to ensure that during the summertime, internal temperatures in patient areas do not exceed 28°C (dry bulb) for more than 50 hours per year taking into account the level of design risk for the application.

2.12 Certain non-patient areas may also require cooling and will typically include some laboratories, central wash-up and other areas which are subject to high equipment heat gains.

2.13 Where deep planning of other continuously occupied spaces, for example offices, is unavoidable, there will also be occasions when acceptable levels of comfort can only be maintained by cooling. Planning solutions of this type however will be exceptional.

2.14 Refrigeration plant should be of sufficient capacity to offset heat gains and maintain areas at a temperature that does not exceed the external design

shade temperatures by more than about 3°C taking into account the level of design risk for the application.

Air-conditioning

2.15 Full air-conditioning is only required in a very small number of areas within healthcare buildings and due to the capital and running cost its inclusion should be kept to a minimum. Paragraphs 3.14, 3.15 and 4.91-4.93 also refer.

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2.16 Areas whose functions may warrant the installation of air-conditioning, include operating departments, intensive therapy units, manufacturing pharmacies and areas with particularly sensitive equipment.

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Deleted: sensitive equipment where the environment needs to be maintained within specified limits to prevent equipment failure.

Specialist ventilation

2.17 Due to the nature and extent of activities carried out in healthcare buildings, there will be a need for a wide range of specialist ventilation systems. The types of system which are generally required in individual departments and typical arrangements are given in Section 7.

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2.18 The activities within some departments will require the provision of local exhaust ventilation (LEV). This is a statutory requirement under COSHH wherever the escape of chemicals, toxic fumes, biological material or quantities of dust into the general area would present a hazard to the occupants.

Ventilation for general areas

2.19 Table A1 in Appendix 1 provides recommended air change rates, temperatures and pressures for general areas which require mechanical ventilation in healthcare buildings.

Use of natural ventilation

2.20 The air tightness of new buildings has improved to the point that infiltration through building leakage can no longer be relied upon to provide sufficient air flow. Attention must therefore be given to the provision of purpose made ventilation openings to achieve the necessary flow rates. The air entering the openings may need to be controlled by motorised dampers linked to temperature and / or occupancy sensors in the ventilated space.

2.21 Internal partitions, fire compartment walls and closed doorways can often impede the flow path, and when this happens, the process will be more dependent on single-sided ventilation. Nevertheless, even with this degree of compartmentation, acceptable ventilation may still be achieved without window openings which would prejudice safety, security or comfort.

2.22 Some types of window, for example, vertical sliding, can enhance single sided air change by temperature difference, and these will improve the overall rate of

natural ventilation in protected or sheltered areas where the effect of wind pressure is likely to be minimal.

2.23 It is generally considered that natural cross-flow ventilation is able to give reasonable air distribution for a distance of up to 6 metres inwards from the external facade, provided that reasonably clear air paths are maintained. Beyond this distance in areas where clear air paths cannot be maintained and in areas where high minimum air change rates are specified, mechanical ventilation should be provided.

2.24 Further information can be found in SHTM 55 'Windows', BS5925 'Code of practice for ventilation principles and designing for natural ventilation' and CIBSE Applications Manual AM10: 'Natural ventilation in non-domestic buildings'.

Mixed mode ventilation

2.25 An assisted form of natural ventilation. Fans are fitted in the purpose made damper controlled ventilation openings. Alternatively a separate ventilation unit may be installed. In both cases the dampers and fans are controlled under the dictates of temperature and occupancy sensors to ensure a minimum air flow rate while taking advantage of natural ventilation effects when present.

2.26 Where natural or mixed mode ventilation is adopted with complex air paths, the designer should produce an air flow diagram in order to ensure correct provision of air transfer devices. CIBSE Applications Manual AM13: 'Mixed mode ventilation in non-domestic buildings' gives guidance.

Mechanical extract ventilation

2.27 General extract systems can vary in complexity from a single wall-mounted fan to a ducted air system with dual extract fans.

Deleted: Both foul and general

Deleted: for each facility,

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2.28 Replacement air is generally provided by a central supply system (as described below). Unless special precautions are taken, the latter may result in an unacceptable level of draughts occurring in winter, and possible risk of unacceptable levels of noise transmission.

2.29 If individual systems are used, the ventilation can be operated intermittently, provided it continues to run for at least 15 minutes after the room is vacated, as with light switch-operated fans in individual toilets.

2.30 If general exhaust systems are used; it is recommended that filtered and tempered replacement air is provided via a central supply plant to adjoining lobbies or corridors, to prevent the risk of discomfort caused by the ingress of cold air. Fire compartmentation requirements must be maintained.

2.31 Information on specialist extract systems is given in Section 7.

Mechanical supply systems

2.32 Where mechanical supply systems are required, the fresh air should be tempered and filtered before being delivered to the space, to avoid discomfort.

2.33 The air should be heated using a constant or variable temperature source, but generally only to the space air temperature. In most instances, the low pressure hot water heating (LPHW) should offset any fabric loss, so that set-back room temperatures can be maintained during unoccupied periods without the need for the ventilation system to operate.

Balanced ventilation

2.34 Balanced ventilation systems are merely a combination of a supply and extract system of equal volume; and either a single space or a whole building may be considered to be balanced. A balanced system is necessary in instances where it is essential to maintain consistent air movement within an area, for example, treatment rooms.

Cascade ventilation

2.35 In operating departments it is normal practice to supply air to the operating room, and allow it to pass through less clean areas – corridors, utility rooms etc. (from where it is eventually extracted).

Deleted: exhausted.

Recirculation systems

2.36 Due to the nature of the use of mechanical ventilation systems within healthcare buildings, there are few opportunities for the application of recirculation air systems. They are however normally used for HEPA filtered clean room applications where the extract air is significantly cleaner than the outside supply. Recirculation is also routinely used in the canopy section of Ultra Clean Operating theatre ventilation systems.

2.37 Where the designer is considering the installation of a recirculation air system, due account must be taken of:

- minimum fresh air supply volume required by the Building Regulations (currently 20%);
- prevention of contamination of supply air from vitiated air in extract systems;
- prevention of stratification occurring within plenum chambers and mixing boxes which may result in freezing of downstream coils;
- ensuring sufficient velocities through control dampers (ideally 5-6 m/s) to provide suitable authority; and good shut-off;
- modulating control of mixing to provide optimum on-plant conditions;

- use of 'free cooling' by cycling the dampers to minimum fresh air when the enthalpy of the outside air is above that of the extract air under conditions when cooling is required.

Chilled beams

2.38 The use of chilled beams for the provision of heating, cooling and ventilation is increasingly common in healthcare premises. The use of Active Chilled Beams providing tempered filtered air to a heating / cooling device within the room can provide effective local control of environmental conditions.

2.39 Care should be taken in positioning chilled beams to ensure the avoidance of cold draughts particularly when used in the cooling mode. The control settings should ensure that the external elements of the beam are always above dewpoint.

2.40 Consideration should be given to the ease with which specific types of chilled beam units can be accessed for cleaning having regard to the need to control the infection risk. The impact of maintenance requirements on room availability should also be considered.

Split comfort air-conditioners

2.41 Split comfort air-conditioners, room conditioners or cassette units are used increasingly where there is a small local requirement for cooling for operational purposes. They can provide an effective economic solution to cooling needs, where a central refrigeration system is not practicable.

2.42 The units re-circulate room air so provision for a fresh air make up, either by natural or mechanical means, to the standard required by the Building Regulations must be provided.

2.43 The recirculation of room air presents problems with indoor air quality (IAQ) and may increase the risk of healthcare associated infection (HAI). Split units should not therefore be used in critical patient areas.

2.44 Split units may be used for single room applications or as multiple linked units that can independently provide either heating or cooling all served by a single outdoor unit. These systems enable good temperature control of a number of rooms with maximum energy efficiency.

2.45 Whether single or multiple systems are used, it is essential that the designer gives due consideration to the source of electrical supply, location of the heat rejection unit, environmental effects to the refrigerant used and drainage provision for the cooling coil condensate.

2.46 The units will require routine maintenance for filter change and cleaning; they should therefore be installed in an accessible position.

Dilution ventilation and Clean Air Flow Paths

2.47 Dilution ventilation has in the past been used to control levels of hazardous substances in a space. This approach is no longer considered acceptable. The COSHH Regulations require that known hazardous substances should be substituted for safe alternatives. If this is not possible then they should be controlled at source by the use of closed systems such as anaesthetic gas scavenge units or exhaust protective enclosures such as fume cupboards.

2.48 The exposure of staff to casual spillages of substances such as medical gases in anaesthetic rooms should in the first instance be dealt with by establishing a clean air flow path. Air should be supplied at high level and extracted at low level directly behind the anaesthetic equipment position. The philosophy of establishing a clean air flow path from the supply point; to the staff; on to the patient and out via a low level extract would also apply in recovery rooms and maternity delivery rooms including labour, delivery, recovery & post partum (LDRP) Rooms. A suitable air change rate will provide dilution ventilation as an additional safeguard, see Table A1 in Appendix 1 and Table A2 in Appendix 2, Note c.

2.49 In operating theatres the patient will be on a closed breathing circuit in a room with a high air change rate. Under these circumstances the dilution effect would be considered sufficient to control any casual exposure to anaesthetic gases.

Mechanical ventilation systems

System selection

2.50 Natural ventilation is always the preferred solution for a space, provided that the quantity and quality of air required, and the consistency of control of ventilation to suit the requirements of the space, are achievable with this method. If this is not the case, a mechanical ventilation system will be required.

Choice of central/local plant

2.51 Mechanical ventilation is expensive to operate, and as such, should be controlled to operate when the space being served requires to be ventilated. In addition, loads on refrigeration plant are rarely constant owing to changes in solar gain, occupancy and use of heat-generating equipment and lights, therefore control of temperature is critical.

2.53 If the ventilation of loads throughout a department or building are in phase, or are not significant, a central plant with single zone control can be adopted. However, this is rarely the case, and elsewhere, the condition or quantity of supply air to different areas or zones of the building must be varied accordingly. This can be done by providing either individual plants to each zone, or separate zone terminal control. Where there is a high density of rooms with similar ventilation requirements in an area of a building or department, it is usually economical to combine them into a central system.

2.54 In large buildings, a choice between a single distribution system and multiple smaller systems may arise. Large distribution systems and their plant can have the advantage of lower operating costs, but require more space for vertical shafts. In general, very long runs of ducting should be avoided to prevent undue heat losses or gains, excessive leakage, and difficulties in balancing during commissioning. As the pressure losses in the long runs will be greater and a higher initial static pressure with be required, this will lead to a more expensive class of ductwork. Multiple smaller distribution systems may be more expensive in capital and operating costs but they avoid long runs, large ducts and vertical shafts, and this may reduce overall building costs. They also provide a more robust service as the failure of an individual system does not prevent the use of the rest of the building.

Zoning of the building

2.55 The efficiency and effectiveness of any ventilation or air-conditioning installation depends largely on the zoning and control of the installation. The factors to consider when determining the zoning of a ventilation system for a building or department are:

- periods of occupancy;
- fresh air/ventilation requirements;
- smoke control.

2.56 Where the ventilation system is not merely tempering the air, but also providing the heating and/or cooling requirements, the following additional factors will need to be considered:

- internal or peripheral location;
- orientation of windows;
- variation in internal loads;
- level of control required.

2.57 For single zone plant in staff areas, local control (with a run-on-timer if required) is recommended, as this can be turned off when the space is not in use, thus saving both thermal and electrical energy. Most supply and extract systems, conversely, are required to operate continuously while the department is occupied, thus some form of time or use control is necessary.

2.58 The control of individual plant items is covered in Section 4, with examples of typical control strategies in Section 6. For control of particular specialist ventilation and air-conditioning systems refer to Section 7 of this document.

2.59 On very rare occasions a duplicate standby air handling plant may be justified. If installed it must be provided with a gas-tight damper at its junction with the supply distribution duct, so that no back-flow can occur. Standby plants can become sources of contamination if warm moist air is allowed to dwell within them. Their design and control system must ensure that this cannot happen.

Specific requirements for hospital departments

2.60 Specific requirements for individual spaces and departments are included in the Health Building Notes (HBNs) and Activity Database (ADB) A-Sheets, or Scottish Health Planning Notes.

3.0 Assessment of service requirement

Selection of design criteria

External design conditions

3.1 The most accurate data that is available for the summer and winter conditions at the site should be used. The Metrological office can supply data for the United Kingdom.

3.2 Healthcare mechanical ventilation systems will normally be 'full fresh air'.

3.3 Local adjustments such as for height above sea level, exposure factor, or other climate peculiarities, should be made as appropriate.

Internal design conditions

3.4 The design conditions selected within patient areas must strike a balance between the comfort requirements of staff and patients, who often have very different levels of clothing and activity.

3.5 Recommendations for the dry resultant temperature and humidity of individual spaces are shown on Activity Database (ADB) A-Sheets. Appendix 1 Table A gives a summary.

Minimum fresh air requirements

3.6 For most applications involving human occupancy, the dilution of body odours is the critical factor in determining ventilation requirements; and where natural ventilation or mechanical full fresh-air systems are used; all ventilation air will be fresh.

3.7 Where odour dilution is the overriding factor, it is recommended that 10 litres/second/person should be taken as the minimum ventilation rate.

3.8 Smoking is not permitted in healthcare premises. If permitted for example in residential care, it will be confined to designated areas. It therefore follows that these areas will contain a high percentage of smokers so the ventilation rate would be at least 36 litres/second/person for these applications (CIBSE Guide A; Table 1.10).

3.9 In non-standard applications such as laboratories, aseptic suites, operating departments, etc. the particular requirements for each area should be considered independently in order to determine the overriding minimum requirement for ventilation.

Limiting supply air conditions

3.10 For most applications in healthcare buildings, it is the temperature differential between the supply and room air, rather than the actual temperature of the supply air which is the critical factor. The maximum recommended supply-to-room air temperature differential is:

summer cooling: - 7K

winter heating: + 10K

3.11 It is also necessary to keep supply air humidity below 70% during winter in order to minimise risks associated with condensation.

Air purity

3.12 In healthcare premises, the standard of filtration will depend on the activities within the occupied spaces. With the exception of special areas, (for example manufacturing pharmacies), the requirement for aerobiological needs is not stringent and filtration is only required to:

- maintain hygienic conditions for the health and welfare of occupants, or for processes such as food preparation;
- protect finishes, fabrics and furnishings, to reduce redecoration costs;
- protect equipment either within the supply air system that is, to prevent blocking of coils, or in the space itself to prevent dust collection.

3.13 Given that almost all viable particles will originate from the occupants of a space and not from the incoming air, dilution is the more important factor aerobiologicaly. Therefore, for general areas a G4 filter will be suitable. More critical areas will require a F7 filter. HEPA filters will only be required in Ultra Clean systems.

Humidity control requirements

3.14 Providing humidification is expensive in terms of plant, running costs and maintenance, and therefore its use should be restricted to where it is necessary for physiological or operational reasons.

3.15 Humidification was originally required for some healthcare applications e.g. operating theatres, in order to control the risk associated with the use of flammable anaesthetic gases. The use of such gases has now ceased. Humidification is therefore no longer required unless there is a very specific application requirement.

Maximum noise levels

3.16 Noise will be generated in an air distribution system by the fan, ductwork fittings, dampers and grilles. The specified maximum noise level will depend on the activities within the occupied spaces.

3.17 The overall noise levels should not exceed the values given in Scottish Health Technical Memorandum 08-01 – 'Acoustics', although general requirements are given in Table 2.

3.18 Attenuation should be incorporated into the ductwork system or plant arrangement as necessary to reduce noise from fans and plant items in order to achieve the acceptable limits within the rooms at the design air flows.

3.19 Plant noise should not be greater than 80 dB(A) within the plant room from the fans, coolers, heaters, humidifiers etc, when starting up or running; and should be reduced to lower noise levels where the plant is near to departments sensitive to noise.

3.20 Attention must be given to the reduction of tonal components. High tonal components from air diffusers etc, can seriously disturb concentration over longer periods even when the overall noise level is low. Broadband noise causes less annoyance. Reference should be made to SHTM 08-01 'acoustics'.

3.21 The designer requires knowledge of the total hospital layout and operational policies, to assign acceptance magnitudes to all the possible noise sources, in order to arrive at the correct rating.

Room	Overall noise level - NR	Ventilation plant commissioning - NR	Ventilation plant design - NR
Operating department	50 (55)	45	40
Ward areas	33	30	30
Sanitary facilities	45	40	35
Industrial areas	50	45	40
Circulation areas	50	45	40

Table 2: Interior noise level

3.22 In Table 2 the overall noise level takes account of all internal and external noise sources. The commissioning noise level is the level measured with a sound level meter in the unoccupied room, taking account of the external noise together with the noise generated by the ventilation system. When occupied and in use, this commissioning level will constitute a continuous background noise which will allow the overall noise level to be achieved. The ventilation plant design noise level is that generated by the plant alone with no other noise source being considered. The levels suggested make recognised allowance for the ingress of environmental noise which must be considered in the overall design, that is, in specifying the attenuation of walls, partitions, ceilings, etc.

3.23 The recommended criterion is measured as the "A" weighted sound pressure level expressed in decibels, which should not be exceeded for more than 10% of the time.

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3.24 The designer must also consider noise escaping to the external environment and this must not be unacceptable to occupants of adjacent buildings.

Calculation of building loads

Air infiltration

3.25 Air infiltration occurs due to a complex combination of wind pressure, thermal effects, location relative to other features and the construction standard of the building. The infiltration rate is governed by the size and number of openings in the building envelope and the complexity of internal air paths.

3.26 CIBSE Guide A; Section 4 provides information and formulae for the calculation of air infiltration and natural ventilation of buildings. In all cases the requirements of the appropriate section of the Building Regulations must be met.

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Summertime temperatures

3.27 The calculation method for determining the summertime temperature is described CIBSE Guide A; Section 5. However, it is very important to select the time of day and time of year of peak loadings for the calculations, which is dependent upon the orientation and proportion of solar to total heat gain. In establishing outside design values, the design risk having regard to the function and occupancy of the building should be considered.

3.28 Where calculations indicate that internal temperatures will frequently exceed the selected design external shade temperature by more than 3K for a period that exceeds the building design risk, methods of reducing temperature rise should be implemented. Options include;- reducing solar and casual gains, the use of chilled beams or ceilings, increasing ventilation rates or providing mechanical cooling. In some situations it may be possible to alter the thermal mass of the structure to 'move' the peak temperature event time so that it occurs outside of the occupancy period. Calculations and thermal modelling should be undertaken to ensure that during the summertime internal temperatures in patient areas do not exceed 28^{o}C dry bulb for more than 50 hours per year. It has been found that there is a relationship between preferred indoor temperatures and mean outside temperature. Fig A2 in CIBSE Guide A indicates this relationship.

Peak heating load

3.29 Peak heating local calculations are necessary on all mechanical supply systems to establish the size of heater batteries and subsequently the central plant.

3.30 Where ventilation systems provide tempered air to spaces which have supplementary LPHW to offset the building fabric losses, the plant heating load should be calculated based on the external winter design temperature, the design internal air temperature, and the calculated total air volume (including a suitable allowance for leakage).

3.31 Where the ventilation system is the only means of heating a space, an increase in load equivalent to the calculated fabric heat losses from the space should be

added to the ventilation load. A check of supply temperature difference should be made. If it exceeds 10K the ventilation supply volume should be increased to suit.

Condensation Risk

3.32 A check should be made to ensure that the selected air condition will not lead to surface condensation on low-temperature elements of the ventilated space.

3.33 Where there are local sources of moisture that would require excessive levels of ventilation to avoid condensation, the designer should consider the capture and removal of moisture at the source of the evaporation via an exhaust hood or similar device.

3.34 In intermittently heated buildings, it is necessary to consider the condensation risk at night set-back conditions as well as during normal operation. Calculation methods for this assessment are given in CIBSE's Guide A.

Peak cooling load

3.35 In addition to the base data of air flow rates and temperatures, when calculating cooling loads, the designer must take into account:

- solar cooling loads;
- surface conduction cooling loads;
- internal gain cooling loads;
- cooling loads due to high-level humidity control;
- method of control of internal conditions;
- fluctuations in internal temperatures.

3.36 When the peak internal loads have been assessed and a suitable allowance made for non-coincidence, the supply temperature can be calculated.

3.37 Once the lowest required supply temperature of the air handling unit has been established, and an allowance made for temperature rise through the fan and ductwork (usually 1K for low pressure systems), the off-plant enthalpy can be established from a psychrometric chart or table.

3.38 The cooling loads for all plants on the chilled water system should be calculated at each of the individual peak times in order to establish accurately the required (diversified) capacity of the chiller.

Annual energy consumption

3.39 Annual energy consumptions of simple heating-only ventilation systems are simple to calculate, based on supply-to external air temperature rise, and frequency of occurrence of external temperatures as given in CIBSE Guide A.

3.40 Minimum air volumes are usually fixed by the room loads or fresh air requirements; however, the designer may increase air flow to some rooms or zones in order to balance loads, as detailed in the paragraphs on “Calculation of plant requirements.

3.41 The method of zoning and control can significantly influence energy consumption.

3.42 The nature of air-conditioning operation, that is cooling and reheating for humidity or zonal temperature control, makes prediction of energy consumption very complex. It is imperative that these calculations are performed to ensure optimum energy efficiency.

3.43 The concept of load and plant operation charts is outlined in the CIBSE Guide A. The method requires the designer to establish the minimum and maximum loads on all zones across the range of external temperatures between winter and summer design conditions. Once the load chart is complete, the plant chart converts the loads to supply temperatures, which are then superimposed on external air temperatures.

3.44 When all temperatures for all zones are plotted on the plant operation chart, set points and resetting schedules can be established. From this information, the outputs of individual heaters, coolers and humidifiers can be established at any given external temperature. When those loads are computed against annual frequency of occurrence of external temperatures as given in CIBSE Guide A, the annual energy consumption of individual elements, and thus the air-conditioning system, can be established.

3.45 In order to prevent surface condensation occurring, it is necessary to provide sufficient ventilation to maintain the maximum and ambient dew-point temperature below the lowest surface temperature, the coldest usually being the glazing. Paragraphs 3.33 and 3.34 also refer.

Calculation of plant requirements

Air supply volumes

3.46 The minimum air supply volume for a room is determined by the greater of the three criteria, viz:

- the minimum fresh air requirement;
- the minimum supply volume for the room load as determined by the maximum heating or cooling supply temperature differential;
- the desired/required air change rate.

Plant sizing

3.47 Once the design air flow has been established the cross-sectional area of the air-handling unit can be calculated based on a maximum coil face velocity of 2.0 m/s.

3.48 In order to establish the length of the air-handling unit, it will be necessary to refer to manufacturers' literature, ensuring all necessary access panels and components are included as detailed in Chapter 4.

3.49 The fan duty should be calculated by adding the resistances of all elements which contribute to the pressure drop of the index circuit.

3.50 The main elements which must be considered are:

- inlet or discharge louvres;
- plant entry and discharge;
- attenuators;
- components within the air-handling unit;
- duct-mounted heaters and filters (including a dust allowance);
- ductwork distribution;
- ductwork fittings, including: fire dampers, volume control dampers, bends and sets, tees, changes of section;
- air terminal device;
- discharge velocity.

3.51 Where packaged air-handling units are installed, the fan pressure drop is usually quoted as external plant resistance, and thus the designer does not need to calculate the resistances of individual plant items. The designer should, however, ensure that an allowance has been made for filter clogging; and confirm whether the fan pressure quoted is fan total or static pressure.

3.52 Resistances of ductwork and fittings may be obtained from the CIBSE Guide A; however, the designer should exercise some care when using tabulated pressure loss information for fittings which are relatively close together.

3.53 Upon completion of the resistance calculation exercise, the designer should make allowances for calculation and construction tolerances as indicated in Table 3.

Criteria	Low pressure systems	Medium/high pressure systems
Volume flow rate margin for leaking and balancing requirements	+5%	+5%
Total pressure loss margin		
A. for increase in volume flow rate (above)	+5%	+5%
B. for uncertainties in calculation	+5%	+10%
Combined total pressure loss margin	+10%	+15%

Table 3: Typical fan volume and pressure margins

Plantroom size and location

3.54 The ventilation plant and associated equipment should be positioned to give maximum reduction of noise and vibration transmitted to sensitive departments; and at the same time, achieve an economic solution for the distribution of services.

3.55 It is not recommended that noise and vibration generating plant be housed either directly above or below sensitive areas (for example, operating or anaesthetic rooms) unless there is no alternative, in which case, additional care and attention must be given to the control measures.

3.56 The plant must also be located so that it is remote from possible sources of contamination, heat gains and adverse weather conditions. The design should ensure that wind speed and direction have a minimal effect on plant throughput.

3.57 Safe access to and around plant is essential to facilitate inspection, routine maintenance, repair and plant replacement.

Provision of primary services

3.58 Where more than one air-handling plant requires cooling, remote central cooling plants with piped chilled water are preferred. In the case of a single plant, a multi-stage direct expansion cooling coil with refrigerant piped from an adjacent compressor/condensing plant could be considered. If this option is selected, a refrigerant gas detector mounted in the base of the duct and an alarm system audible to the end-user will also need to be provided (COSHH regulations).

3.59 Clean dry steam is preferred for humidification, provided that the boiler water treatment does not render the steam unusable for direct humidification.

3.60 If a suitable supply of steam cannot be obtained from the steam main, a steam generator should be provided locally, or a self-generating humidifier installed. Electric humidifiers require considerable electrical loads and if a gas supply can be derived, this would be preferable. The location of a local steam generator is critical if condensate is to drain back into it.

Inlet and discharge sizing and location

3.61 Air intakes and discharge points should preferably be located at high level, to minimise the risks of noise nuisance to surrounding buildings, contamination and vandalism.

3.62 Intakes and discharges should be designed and located so that wind speed and direction have a minimal effect on the plant throughput.

3.63 Helicopter landing pads in the vicinity of ventilation intakes and discharges can result in large short term pressure changes. This can cause pressure surges in supply systems and reverse air flows in extracts. Exhaust fumes from the helicopter may also be drawn into intakes.

3.64 Intake points should be situated away from cooling towers, boiler flues, vents from oil storage tanks, fume cupboards and other discharges of contaminated air, vapours and gases, and places where vehicle exhaust gases may be drawn in.

3.65 Where intakes have necessarily to be sited at or near ground level, the area around them should be paved or concreted to prevent soil or vegetation being drawn in. They should also be caged or located within a compound to prevent rubbish being left in the vicinity. The likely proximity of vehicle exhausts should also be taken into account when determining the protected area around the intake.

3.66 The discharge from an extract system must be located so that vitiated air cannot be drawn back into the supply air intake or any other fresh-air inlet. Ideally, the extract discharge will be located on a different face of the building from the supply intake(s). In any event, there must be a minimum separation of 4 metres between them, with the discharge mounted at a higher level than the intake.

3.67 Discharges from LEV systems should preferably be vertical and usually not less than 3m above roof level. They should not be fitted with a cowl that could cause the discharge to be deflected downwards.

3.68 Each intake and discharge point should be fitted with corrosion-resistant weatherproof louvres or cowls to protect the system from driving rain. Louvres should be sized based on a maximum face velocity of 2 m/s in order to prevent excessive noise generation and pressure loss.

3.69 The inside of the louvres should be fitted with a mesh of not less than 6 mm and not more than 12 mm to prevent infestation by vermin.

3.70 The duct behind louvres should be self-draining. If this is not practicable, it should be tanked and provided with a drainage system.

3.71 Cleaning access must be provided either from the outside via hinged louvres or by access doors in the plenum behind the louvre. Where a common plenum is provided, cleaning access should be via a walk in door.

Heat rejection devices

3.72 The design conditions given in Chapter 2 make no allowance for the elevated temperatures that can occur on the roof of buildings. Refrigeration condensers and cooling towers should, if practicable, be shaded from direct solar radiation, or the design adjusted to take account of the gain.

3.73 Air-cooled condensers must always be the first choice for heat rejection from any refrigeration plant. Evaporative cooling systems must not be used in healthcare premises unless limitations of space mean that they are the only way that the cooling load can be met. If they are used, national guidance on preventing and controlling *legionellae* must be closely followed.

3.74 Reference should be made to Scottish Health Technical Memorandum 04-01: 'The Control of *Legionella*, hygiene, 'Safe' hot water, cold water and drinking water systems, Part A: Design, Installation and Testing, and Part B: Operational Management, published by Health Facilities Scotland, 2009.

4.0 Air handling unit design and specification guidance

General requirements

Location and access

4.1 Air-handling units should be located in an accessible area secured from unauthorised entry. Siting units in ceiling voids above occupied spaces is not appropriate.

4.2 Units located on roofs must have a safe means of access together with suitable precautions to prevent personnel or equipment falling or being blown off during maintenance activities.

4.3 Units located at ground level should be secured within a compound to prevent unauthorised access. Measures should be taken to exclude vehicles from the vicinity to ensure that exhaust fumes will not be drawn into intakes.

4.4 Units may have a working life of 25 to 30 years. It can be anticipated that over this period there will be a need to access every element within the unit for deep cleaning. It is also quite possible that the main fan and individual heater and chiller batteries will need replacement. Suitably positioned service connection joints and adequate spacing should permit these items to be withdrawn without the need to dismantle other installed plant or equipment. Batteries that are significantly wider than 1metre should be split to permit withdrawal from both sides.

4.5 It is essential that air-handling units are positioned so that all parts are easily and safely accessible for routine inspection and service. If a unit is located against a wall or backs onto another unit then access to all parts must be available from the front. Units greater than 1 meter wide should preferably have access from both sides or access doors large enough to permit the full and safe entry of maintenance personnel.

4.6 Water may be used during routine cleaning or spilt when maintenance is being undertaken. The area around the unit should be tanked to prevent water penetration to adjacent areas and adequately drained.

4.7 Fire precautions should be incorporated in accordance with Firecode. Guidance is available in BS5588: Part 9 and Sections 5 & 6 of this document.

4.8 Combustion equipment must not be located in a fire compartment that houses air handling equipment.

Technical requirements

4.9 The basic technical requirements of the whole of the ventilation system should meet the relevant clauses of the Model Engineering Specification. It should be noted that the 'Model specification' contains a menu of clauses that cover a wide range of applications, so it is important to select only those that are relevant to the specific application.

Note: At the time of writing, Model Engineering Specification C04 was due for revision in order to bring it into line with the revised standards as set out in this Scottish Health Technical Memorandum. Where conflicts in specification arise, the Scottish Health Technical Memorandum takes precedence.

4.10 It is essential that the main plant/ductwork is located far enough above the floor to permit the correct installation of drainage systems for cooling coils, humidifiers and heat recovery systems. Easy access for maintenance of drainage systems and their associated pipework must be provided.

4.11 Organic materials or substances that can support the growth of micro-organisms must not be used in the construction of the plant or its distribution system. The water fittings and materials directory lists suitable materials for sealants and gaskets.

4.12 The plant and its distribution system must not contain any material or substance that could cause or support combustion.

4.13 Plants should have a high standard of air-tightness. The double-skin method of construction with insulation sandwiched between two metal faces is recommended. The panels may be available in a variety of colours at no additional cost. This can aid identification by colour coding of units in a plant room, e.g. green for general ventilation; blue for theatres; red for laboratories and isolation facilities; grey for extract etc.

4.14 The inside of the plant should be as smooth as possible. Channels, rolled angles or formed sections that could trap or hold moisture should be kept to a minimum. If stiffeners are required, they should be fitted externally. If internal bracing has to be fitted it must be of a design that will not trap or hold moisture.

4.15 Airflow across air treatment components such as filters, heat exchangers and humidifiers will be influenced by the pattern of the approaching airstream. If unsatisfactory conditions are created, the performance of the component will be reduced.

4.16 Access to items that require routine service such as filters, frost batteries and chiller batteries should be via hinged doors. The doors should be large enough e.g. 450mm minimum to allow easy access. Items requiring infrequent access such as attenuators may be via bolted on, lift off panels. All doors and panels should be close fitting and without leaks.

4.17 Care should be taken during installation to ensure that electrical and mechanical services are not installed in positions that will reduce or impede access.

4.18 It can be difficult to turn off AHUs in order to inspect filters and drainage trays. Viewing ports and internal illumination will therefore facilitate routine inspection of such items. Viewing ports should be at a convenient height so that temporary ladders are not required. Internal illumination should be provided by fittings to at least IP55 rating. Fittings should be positioned so that they provide both illumination for inspection and task lighting. All of the lights in a unit should be operated by a single switch.

4.19 Access to AHUs and items in the distribution system such as filters or heater / chiller batteries should be via fixed ladders and platforms or pulpit style moveable steps. The installation of distribution ductwork and other electrical or mechanical services should provide sufficient clearance to allow the pulpit steps to be easily wheeled into position.

AHU drainage system

4.20 All items of plant that could produce moisture must be provided with a drainage system. The system will comprise a drip tray, glass trap, air break and associated drainage pipework.

4.21 The drip-tray should be constructed of a corrosion-resistant material, stainless steel is preferred, and be so arranged that it will completely drain. To prevent 'pooling', it is essential that the drain connection should not have an up-stand; and that a slope of approximately 1 in 20 in all directions should be incorporated to the drain outlet position. The tray must be completely accessible or, for smaller units, easily removable for inspection and cleaning.

4.22 Each drip tray should be provided with its own drain trap. The drain trap should be of the clear (borosilicate) glass type. This permits the colour of the water seal to be observed thus giving an early indication of corrosion, biological activity or contamination within the duct. The trap should have a means for filling and incorporate couplings to facilitate removal for cleaning. It should be located in an easily visible position where it will not be subject to casual knocks. The pipework connecting it to the drainage tray should have a continuous fall of not less that 1 in 20.

4.23 Traps fitted to plant located outside or in unheated plant rooms may need to be trace heated in winter. The trace heating must not raise the temperature of water in the trap above 5^{o}C.

4.24 Water from each trap must discharge via a clear air gap of at least 15mm above the unrestricted spill-over level of either an open tundish connected to a foul drainage stack via a second trap, or a floor gully (or channel). A support should be provided to ensure that the air gap cannot be reduced. More than one drain trap may discharge into the tundish providing each has its own air break.

4.25 Drainage pipework may be thermoplastic, copper or stainless steel. Glass should not be used. The pipework should be a minimum diameter of 22 mm and a fall of at least 1 in 60 in the direction of flow. It should be well supported and located so as not to inhibit access to the AHU.

Layout of Air Handling Unit

4.26 The AHU should be arranged so that the majority of items are under positive pressure. Any item of plant requiring a drain should be on the positive pressure side of the fan. A recommended layout is given in schematic from in Figure 3.

4.27 A separate extract unit will generally be required for the area served by each supply unit.

4.28 An energy recovery system will normally be fitted between the supply and extract units.

Provision of dampers

4.29 Fire or smoke dampers shall be provided at the locations required by Firecode. (See paragraphs 5.17 to 5.21).

4.30 Motorised low leakage shut off dampers should be located immediately behind the intake and discharge of each supply and extract system respectively. They should be of the opposed blade type, opening through a full 90^{o} and must close automatically in the event of power failure or plant shutdown to prevent any reversal of the system airflow.

4.31 The quality of motorised dampers is critical. They should be rigid, with square connections fitted with end and edge seals of a flexible material and with minimal play in linkages. The leakage on shut-off should be less than 2%.

4.32 A manually operated isolating damper should be installed between the main AHU and its distribution system to enable the unit to be isolated when cleaning is in progress.

4.33 Good practice will require the fitting of a main volume control damper so that the design airflow rate can be set at commissioning. The damper should be lockable in any position. If it will also be used for plant isolation, it should be capable of being reset to give the design airflow without the need for re-measurement.

4.34 Internal plant isolating dampers or provision for the fitting of shut off plates between items within a unit are not required.

Vibration

4.35 Vibration from a remote plantroom can be transmitted by the structure of the building, may be regenerated and may sometimes be magnified many times. Units should be selected to have the minimum vibration generation and installed on suitable anti-vibration mounts. Pipe and ductwork should incorporate anti-

vibration couplings, preferably in two planes at right angles, as close to the vibration source as possible. Consideration should be given to the use of anti-vibration pipe hangers and supports.

Sequence of components

4.36 The following arrangement of plant components is typical although in many instances not all elements will be required:

- fresh air intake;
- motorised isolation damper;
- frost / fog coil;
- pre-filter;
- energy recovery device;
- attenuator;
- fan;
- blast plate;
- attenuator ;
- chiller battery;
- eliminator;
- heater battery;
- humidifier;
- final filter;
- isolation / volume control damper.

Note: Attenuators may be located in the intake and discharge duct if they are of a suitable type (See clause paragraphs 4.159 to 4.162)

There may be instances where the above arrangement is not appropriate and the plant arrangement should be planned accordingly.

Fans

General requirements

4.37 The fan should be selected for good efficiency and minimum noise level, but the overriding factor should be the selection of a fan characteristic such that the air quantity is not greatly affected by system pressure changes due to filters becoming dirty or external wind effects.

Acceptable types

4.38 Fans can be of the axial, centrifugal, cross flow, mixed flow or propeller type, depending upon the requirements of the system.

4.39 Where used, centrifugal fans should preferably be of the backward blade type, and give an efficiency of not less than 78%. Alternatively, where noise levels are more critical and pressure requirements are lower, forward curved blade fans are acceptable. For high power applications, aerofoil blade fans may be appropriate.

Selection

4.40 Generally, large ventilation systems will use centrifugal fans due to their efficiency, non-overloading characteristics, and developed pressures.

4.41 Forward curved centrifugal fans can overload if allowed to handle more air than they are designed for.

4.42 Alternatively, it may be appropriate to use mixed flow fans in high pressure systems.

4.43 Axial flow or propeller fans are generally only used in local through-the-wall systems, or systems with very low pressure requirements.

4.44 Cross-flow fans have very low operating efficiencies, and thus their use is restricted to applications such as fan coil units.

Location and connection

4.45 Fans are normally positioned to 'blow through' the central plant so that the cooling coil and humidifier drains will be under positive pressure.

4.46 The fan performance figures given by manufacturers in their catalogue data are based on tests carried out under ideal conditions, which include long uniform ducts on the fan inlet/outlet. These standard test connections are unlikely to occur in practice, the designer should therefore ensure as far as is practical that the fan performance will not be significantly de-rated by the system. This objective can be approached by ensuring that the fan inlet flow conditions comprise uniform axial flow velocities with low levels of turbulence.

4.47 Where the outlet duct is larger than the fan discharge connections, there should be a gradual transition, with a following section of straight duct, having a length equivalent to three duct diameters.

4.48 The design of the fan intake connection must be carefully considered to avoid swirl in the airstream. When the air spins in the same direction as the impeller, the performance and power consumption of the fan are reduced. When the air spins in the opposite direction to the impeller the power consumption and noise will increase with hardly any pressure increase. Airstream swirl is usually

induced by large variations across the fan intake caused by the air passing round a tight bend immediately before the intake.

4.49 Where a centrifugal fan is located with a open intake, the clear distance between the suction opening and the nearest wall should be not less than half the diameter of the inlet. If two fans with free inlets are positioned within the same chamber, their adjacent suction openings should be at least 1 diameter apart.

4.50 Airtight flexible joints should be provided at fan inlet and outlet connections. They should be equal in cross-section to the points of connection and not longer than 200 mm or shorter than 100 mm.

4.51 For centrifugal fans, a diffuser screen / blast plate should be fitted immediately downstream of their discharge.

Supply fan drive arrangements

4.52 Where the fan drive is via a motor driven belt and pulley, it should be external to the air stream. This arrangement has the following advantages:

- the fire risk is reduced;
- the drive is visible so it is simple to check that the belt is still there;
- particles shed from the drive belt are outside of the air stream;
- if the belt slips, the “burning rubber smell” is not transmitted down into occupied areas of the premises;
- noise generated by the motor and drive will not be transmitted along the ductwork;
- waste heat is excluded from the system;
- the drive may be through a vee or toothed belt and pulley. The latter have the advantage of eliminating belt squeal on start up and have a longer service life. They are particularly suitable where the fan drive motor is fitted with a soft start and should be located external to the air stream.

4.53 The drive train should be easily visible without the need to remove access covers. Protecting the drive train with a mesh guard is the preferred option. For weatherproof units designed to be located outside, the fan drive will be external to the duct but enclosed. It should be easily visible through a viewing port with internal illumination and access via a lockable hinged door.

4.54 For direct coupled fan and motor units, the motor should be out of the air stream.

4.55 For induction drive ‘plug’ motor arrangements (where the motor is fitted within the fan and is integral to it) and in line axial fans with a pod motor; the fan / motor combination may be within the air stream **provided** the motor windings are protected from over temperature by a thermister and lockout relay.

Extract fan drive arrangements

4.56 The preferred method where the fan drive is via a motor driven belt and pulley arrangement will be to locate it external to the air stream.

4.57 The fan drive and motor may be located inside the duct within the air stream **provided** the motor windings are protected from over temperature by a thermister and lockout. The drive train should be easily visible through a viewing port, have internal illumination and access via a lockable hinged door.

4.58 Where the system air is explosive, aggressive or has a high moisture content, the extract fan motor must be located outside the air stream. This is generally achieved with axial fans by using a bifurcated unit.

Control

4.59 Fans in healthcare applications are normally either single or two-speed. Where there is a requirement for two-speed operation, this is generally via a local user control (for example, in a hood extract system to provide a boost facility) or via a time schedule for energy saving during unoccupied periods.

4.60 Normally only a single motor is required with a standby motor available for fitting as necessary or fitted but not belted. Twin, run and standby motors with the standby being jockeyed around are not required.

4.61 Where there is a specified requirement for stand-by fans, the system should incorporate an automatic changeover facility activated via an airflow sensor. Fault indication should be provided.

4.62 The control of fans in terms of start up and run is increasingly being vested in computer software. Inverter drive, variable speed, soft start systems are becoming a standard approach. It should be remembered that most healthcare applications require known amounts of air to be delivered while the system is in use. Constant volume systems that deliver specified air change rates are therefore the norm. Duct or room pressure controlled, variable speed systems have a very limited application in healthcare.

4.63 It is necessary to ensure that should the computer control system or its software develop a fault then the fan can be switched to a direct start, fixed speed, manual operation. This is particularly important for critical care systems serving operating suites, high dependency care units of any type, patient isolation facilities, laboratories and pharmaceutical production suites. Off site software support is no substitute for the ability of on site staff to override the automatic control and keep the system operating in an emergency. Under these circumstances actions that may shorten the life of the plant are considered of secondary importance to that of preserving the health and safety of patients and staff.

Heater batteries/heater coils

General requirements

4.64 Frost batteries are installed to protect the downstream filters from low temperature, high humidity intake air conditions. As they handle unfiltered air they should be constructed of plain tubing without fins and be as near to the outside as possible to minimise condensation during cold weather. Access for cleaning will need to be provided to both sides of the coil.

4.65 Where steam coils are used for a frost battery, they may be constructed using spiral fined copper tube. As they will be prone to fouling the tube layout and spacing should permit easy access for regular cleaning.

4.66 Main and branch heater batteries should be constructed of solid drawn copper tube coils with copper fins, generally connected in parallel.

4.67 Where there is a wet heating system in the areas served, the main heater battery should be sized for the ventilation requirements only, and not for the fabric loss.

4.68 Access for cleaning must be provided to both sides of all frost batteries and heater batteries.

Acceptable types

4.69 Electric, water or steam heater batteries may be considered; however, electric heater batteries are expensive to operate and where there are alternatives, their use should be restricted to low power use, for example trimming control.

4.70 Where steam supplied heater batteries are used, their control, venting and trapping systems should be designed so that a vacuum cannot occur within the coil. The condensate drainage arrangements should not allow pressure to build in the main resulting in a back up of condensate in the coil.

Location

4.71 Where possible, wet trimmer heater batteries should be located in plant areas.

4.72 Where it is necessary to locate heater batteries in false ceilings etc, consideration should be given to the use of electric heaters. If this is not practicable, drip-trays should be installed under both the battery and the control valve assembly to protect the ceiling. A moisture sensor and alarm should be fitted in the tray. In any event, to facilitate maintenance access, they should be located above corridors or other non-critical areas and never above patient occupied spaces.

4.73 Auxiliary fan coil units should not be installed in the ceiling above an occupied space. They should be accessible for routine maintenance and cleaning without the need to cause significant disruption to the operation of the department that they serve.

Control

4.74 LPHW frost coils should be controlled by an off-coil temperature sensor operating a motorised valve to provide a minimum plant "on temperature" of between 2°C and 5°C. The off-coil temperature of the frost coil is generally sensed by a serpentine thermostat downstream of the coil or upstream of the next plant item. This thermostat will shut the fan down if any part of the air stream is below the minimum set-point.

4.75 Steam supplied frost coils should be fitted with an on/off control operated by a temperature sensor mounted upstream of the battery. These are normally set to fully open the control valve when the outside temperature drops to +1°C. This will ensure that there is no standing condensate in the base of the coil.

4.76 The main heater battery should be controlled in the same manner under the dictates of either an off-coil temperature sensor, or a room temperature sensor, depending on the plant configuration and method of control. Trimmer heater batteries are generally controlled by one or more averaging temperature sensors within the room or rooms in the zone.

4.77 Heater battery control valves should drive closed on system shutdown or fan failure. The control system should then automatically set to provide frost protection.

Cooling coils

General requirements

4.78 Cooling coils will need to be decontaminated periodically. They must have good access both up and downstream. Hinged access doors with viewing ports and illumination inside the duct should be provided both sides of the coil.

4.79 An eliminator will be required downstream of all cooling coils. The eliminator may take the form of an extension of the coil fins or be a separate device. If a separate device it should be removable as unit to permit cleaning of the coil face.

4.80 All cooling coils must be fitted with their own independent drainage system as specified above. A baffle or similar device must be provided in the drip tray to prevent air bypassing the coil. The tray should be large enough to capture the moisture from the eliminator, bends and headers.

4.81 Where coils are greater than 1m high, intermediate drip-trays will be required.

Selection

4.82 Cooling coils supplied with chilled water are the preferred option. For small loads or where chilled water is not available, direct expansion coils may be used.

4.83 Care must be taken in selection to minimise electrolytic action resulting from condensation on the air side. Coils constructed from copper tubes with copper fins extended on the downstream side in the form of an eliminator, and electro-tinned after manufacture are preferred. Aluminium fans should only be used if vinyl-coated.

4.84 All parts of the coil and its associated ductwork in contact with moisture must be manufactured from corrosion-resistant materials. Pressed steel coil headers, even if treated, have been shown to be prone to corrosion over time and should not be used. Steel mounting frames and casings present similar problems so stainless steel is preferred.

Location

4.85 Micro-organisms which multiply in moisture cannot be avoided when the coil is dehumidifying, but the risk of infection will be reduced by locating the final filter downstream of the coils.

4.86 Cooling coils in AHUs should be located upstream of the final filter.

4.87 Where any cooling coil has to be located above a ceiling, drip-trays should be installed under both the coil and the control valve assembly to protect the ceiling. A moisture sensor and alarm should be fitted in the tray. To facilitate maintenance access, they should be located above corridors or other non-critical areas and never above patient occupied spaces.

Control

4.88 There are two basic methods of control for cooling coils:

- off-coil control – used in multi-zone systems or single-zone systems where close humidity control is required, to provide a constant maximum off-plant condition which satisfies the temperature and high humidity requirements of the zone with the highest load;
- sequential control – used in single-zone systems, or multi-zone systems with averaging sensors where close control is not required. A room or duct temperature sensor controls the cooling coil and heater battery in sequence to maintain constant room conditions.

4.89 The advantage of off-coil control is that accurate humidity control can be provided without relying on humidity sensors, which are prone to inaccuracy and drift. Off-coil control is however, expensive to operate in terms of energy consumption, due to the fact that there is no feedback of room loads, and thus at low loads and in systems where there are large zonal variations, significant over-cooling and reheating will occur.

4.90 On systems with two-speed operating, it is usual to isolate the cooling coil upon selection of low speed. In addition, on system shutdown, low airflow or fan failure, the cooling coil must be isolated.

Humidifiers

Design need

4.91 Humidification was originally required for some healthcare applications in order to control the risk associated with the use of flammable anaesthetic gases. The use of such gases has now ceased. Humidification is therefore no longer required unless there is a very specific application requirement.

4.92 Operating theatre AHUs do not generally require humidifiers but provision for their retro fitting in terms of space provision and a capped drainage system should be provided.

4.93 Where humidification is required, it will be subject to the specific requirements set out below. These are intended to ensure that the unit will operate safely and not become a source of contamination.

General requirements

4.94 The most important requirement for a humidifier is to create complete mixing of the steam with the air; and the manufacturers' instructions should be followed regarding minimum distances, which should be allowed before bends or other components. This is particularly important with respect to a filter mounted downstream. If it becomes saturated by the humidifier, organisms can grow through the filter and be released into the duct. These may then be carried on the airstream into an occupied space.

4.95 The section of ductwork containing the humidifier may need to be periodically decontaminated. Hinged access doors with viewing ports and internal illumination should be provided. A label warning that the device emits live steam and should be isolated prior to opening should be affixed to the access door.

4.96 All parts of the humidifier and its associated ductwork in contact with moisture must be manufactured from corrosion-resistant materials. Stainless steel is preferred.

4.97 The electrodes of and self generating electrode boiler type humidifier should be stainless steel.

4.98 All humidifiers must be fitted with their own independent drainage systems as detailed in paragraphs 4.72 and 4.87 or 4.20 to 4.25.

4.99 For self and locally generated steam humidifiers, the cleanliness of the water supply is essential for their safe operation. Provision should be made for draining down supply pipework and break tanks for periodic disinfection and cleaning during periods when they are not required in service.

4.100 The addition of treatment chemicals for continuous control of water quality for humidifier/air handling units should be avoided. Consideration could be given to installing a UV system to control microbiological growth. Given the limitations of

UV systems, however, this will require filtration to high quality to ensure the effectiveness of exposure of organisms to the UV irradiation. As with all water treatment systems the unit should be of proven efficacy and incorporate UV monitors so that any loss of transmission can be detected.

Acceptable types

4.101 Only steam injection manifold-type humidifiers are considered suitable for use in health building air-conditioning systems. Water humidifiers of any type should not be used.

4.102 Steam may be derived from the central steam supply, or generated locally either within or adjacent to the humidifier.

4.103 The introduction of steam should be by an appliance specially designed to discharge dry steam into the air-conditioning system without objectionable noise or carry-over of moisture.

4.104 During the design stage, consideration should be given to the proposed methods for the regular cleansing of the humidifier(s) and their components.

Selection

4.105 The number and length of steam injection manifolds to be used is dependent on various factors such as duct cross-section area, air velocity, dry bulb temperature and manifold design. Guidance from the manufacturer should be closely followed.

4.106 A mains steam humidifier can be noisy and will be difficult to control if it is operated at an excessive steam pressure. It should be sized for an operating pressure of approximately 1 bar. The pipework supplying it should be provided with a dirt pocket, pressure reducing valve and steam trap installed as close as practicable to the humidifier, so that the steam condition at entry is as dry as possible. A temperature switch on the condensate line (or equivalent design provision by the humidifier manufacturer) should be incorporated to prevent 'spitting' on start-up.

4.107 Most operational problems with mains steam humidifiers arise because of back-pressure in the condensate discharge line which will result in flooding into the duct. Unless the condensate from the device can be discharged and collected at atmospheric pressure, it should be discharged directly to drain.

4.108 A local steam generator, where used, must be fed with potable quality water. Additional water treatment to the standard set out above may be required. If the humidifier is unused for a period exceeding 48 hours, it must automatically drain its water content, including that contained in the supply pipework, right back to the running main and leave itself empty.

4.109 Some steam generators are of a type that requires regular cleaning and descaling. The design must allow for them to be installed such that they can be

physically isolated from the air duct in order to prevent contamination of the supply by cleaning agents while this is taking place.

Location

4.110 Careful sitting of the humidifier injection mainfold is required to prevent the steam impinging onto the side(s) of the duct, condensing and generating excess moisture.

Control

4.111 Accurate humidity control can only be provided on single-zone systems, or multi-zone systems with zonal humidifiers. In the above systems, humidity sensors control the humidifier for low-level humidity control, and override the temperature controls to open the cooling coil valve for high-limit humidity control.

4.112 Multi-zone systems are more usually controlled by a minimum humidity sensor located in the supply duct(s) following the last heater battery.

4.113 Overriding controls separate from the normal plant humidistat should be installed. Their purpose is to prevent excessive condensation in the conditioned space when starting up. A time delay should be incorporated into the humidifier control system such that the humidifier does not start until 30 minutes after the ventilation/plant start-up. In addition, a high limit humidistat should be installed to limit the output of the humidifier so that the saturation in the duct does not exceed 70%. This humidistat is to control the added moisture; it is not necessary to install a de-humidifier to reduce the humidity of the incoming air if it already exceeds 70%. The humidifier control system should ensure that the humidifier is switched off when the fan is not running.

4.114 On systems with two-speed operating, it is usual to isolate the humidifier upon selection of low speed. In addition, on system shutdown, low airflow or fan failure, the humidifier should be isolated.

Filtration

General requirements

4.115 The purpose of filtration is to reduce the level of airborne contamination in an air stream. It is generally carried out in stages.

4.116 Filters must be securely housed and sealed in well-fitting frames that minimise air by pass. Air by pass significantly reduces filter efficiency, the higher the filter grade the greater the effect. Mounting frames should be designed so that the air flow pushes the filter into its housing to help minimise air bypass. Mounting frames that withdraw so that the filter can be changed without having to reach into the unit are preferred.

4.117 Neither the filter media, nor any material used in the construction of the filters, should be capable of sustaining combustion. The filter media should be such that particles of it do not detach and become carried away by the airflow.

4.118 Filters need to be readily accessible for replacement so a hinged access door should be provided. The upstream side of the filter should be visible for inspection through a viewing port with internal illumination.

4.119 All filters should be provided with a means of visually checking the differential pressure across them. Direct reading dial type gauges marked with clean and dirty sectors are preferred.

4.120 A complete spare set of filters must be provided at handover.

Definition of filter terms

4.121 Particulate air filters are divided into four categories:

- general ventilation filters grades G1 to G4;
- fine filters grades F5 to F9;
- high efficiency particulate filters (HEPA) graded H10 to H14;
- ultra low particulate air filters (ULPA) graded U15 to U17.

4.122 General filters are graded in terms of their 'Synthetic dust weight 'Arrestance'. This represents the percentage of a test dust captured by a filter. 'Arrestance' provides a good indication of a filter's ability to remove the larger, heavier particles found in outdoor air. These are of a size to block finned batteries and large enough to settle out in the air distribution system.

Table 3 - General Filters

BSEN 779 grade (Eurovent grade)	% Arrestance	Notes and typical healthcare application
G1 - (EU1)	< 65	Metal mesh grease filter
G2 - (EU2)	65 < to < 80	Coarse primary filter
G3 - (EU3)	80 < to < 90	Primary air intake; return air; energy recovery device protection
G4 - (EU4)	> 90	General purpose tempered air supply

4.123 Fine filters are graded in terms of their 'Atmospheric dust spot Efficiency'. This is a measure of the filters ability to remove the very fine staining particles found in outdoor air. It will indicate how 'visibly' clean a filter will keep a ventilated space. The staining particles are approximately the same size as most common bacteria so it is also a rough measure of the filters ability to remove micro-organisms.

Table 4 - Fine Filters

BSEN 779 grade (Eurovent grade)	% Efficiency	Notes and typical healthcare applications
F5 - (EU5)	40 < to 60	General purpose panel / bag filter
F6 - (EU6)	60< to < 80	Basic grade bag filter
F7 - (EU7)	80< to < 90	Medium grade bag or pleated paper Conventional operating theatre supply air
F8 - (EU8)	90 < to < 95	High grade bag or pleated paper
F9 - (EU9)	> 95	Basic HEPA filter – Level 8 clean rooms

4.124 High efficiency filters (HEPA and ULPA) are graded in terms of their ability to capture their 'Most Penetrating Particle Size' (MPPS). High efficiency filters self select the particle that they are least able to trap, hence the MPPS. They are then tested against that size of particle. These filters are designed to provide very high-efficiency filtration of particles in the sub-micron size range.

Table 5 - High Efficiency (HEPA) Particulate Filters

BSEN 1822 grade (Eurovent grade)	% Efficiency @ MPPS	Notes and typical healthcare application
H10 - (EU10)	85	
H11 - (EU11)	95	
H12 - (EU12)	99.5	Orthopaedic theatre UCV terminal
H13 - (EU13)	99.95	
H14 - (EU14)	99.995	Pharmacy aseptic suite Cat 3 room extract
U15 – U17	-	Not generally used in healthcare

Selection Primary filters

4.125 All filters should be of the dry type. Panel filters are cheap and disposable with relatively low dust-holding capacity. They are generally used as pre-filters to eliminate large particles which would otherwise clog or cause damage to the fan and finned heating and cooling batteries. Stainless steel frames that hold disposable pre-cut filter pads are preferred.

4.126 General ventilation supply plant should incorporate primary air filters of grade G3, sized for a maximum face velocity of 2.5 m/s. Additional coarse pre-filters may be justified where the intake air is exceptionally polluted. They are sometimes fitted as a temporary measure when building work is being carried out in the vicinity of the air intake.

Secondary filters

4.127 Where a higher standard of filtration is required, secondary bag or pleated paper panel filters would be used. Rigid frame filters incorporating pleated paper elements are preferred over bag filters for critical care applications such as operating theatres.

4.128 In urban or other areas of high atmospheric pollution, a higher standard of filtration may be justified to reduce the level of staining to internal finishes.

Extract air filters

4.129 Extract filtration will generally only be required where heat-recovery devices are installed. There are a very limited number of specialised applications (microbiological safety cabinets and similar LEV systems) where contaminated air is required to be filtered prior to discharge to atmosphere. If it safe for staff to work in a room without wearing respiratory protective equipment, it is safe to discharge the room air to atmosphere without filtration .

Return air filters

4.130 They are used to reduce the load on HEPA filters in re-circulating applications such as Ultra Clean operating suite ventilation canopies and pharmacy aseptic suites.

High efficiency filters – HEPA and ULPA

4.131 HEPA filters are expensive so their use should be kept to a minimum. Applications requiring HEPA filters include the air supply to aseptic suites in manufacturing pharmacies, the discharges from microbiological safety cabinets and isolation facilities.

4.132 If used HEPA filters should be of the replaceable panel type with leak proof seals. They should be installed in a manner that permits on site validation of the filter and its housing. This may involve the release of a Dispersed Oil Particle (DOP) challenge smoke through an injection point upstream of the filter and a measurement of the DOP penetration across the downstream face. Alternatively a particle counting method may be used.

4.133 HEPA filters are sometimes fitted in extract systems to capture hazardous substances or organisms. Design provision must be made for the subsequent safe handling of contaminated filters by maintenance staff. This may be achieved by:

- sealing the hazardous substance into the filter before it is removed;
- providing a system to fumigate the filter to kill any organisms;
- housing it in a ”safe change” unit that permits the filter to be ejected into a bag and sealed without staff having to come into direct contact with it.

4.134 In view of the costs and problems associated with placing HEPA filters in extracts, it is recommended that a full risk assessment be carried out at the design stage. This should include defining the true need for HEPA filters in an extract; validation of its performance at installation; the method of safely changing a contaminated filter; and its subsequent disposal.

4.135 ULPA filters are very expensive and are designed to remove particles below a size that are either surgically or aero biologically significant. There would have

to be exceptional circumstances in order to justify their use in healthcare ventilation systems.

Activated Carbon Filters

4.136 Activated carbon filters are able to remove gases and vapours from an air stream and are graded according to the range of substances they can remove. They are not normally fitted in air-conditioning supply systems.

4.137 They are occasionally fitted retrospectively because the main air intake has been poorly sited and is drawing in traffic fumes. Where used they must be protected by a particulate air filter.

4.138 Activated carbon filters are more commonly used in specialised fume extraction systems when the location of the discharge means that dilution cannot be relied upon to disperse noxious fumes.

Location

4.139 The primary filter should be positioned on the inlet side of the supply fan, downstream of the frost coil. The secondary filter, when fitted, should be on the positive pressure side of the fan. This will prevent air being drawn into the system after the filter and capture any particles shed by items of equipment within the AHU.

4.140 The filter installation must be arranged to provide easy access to filter media for cleaning, removal or replacement, with side or front withdrawal as required.

Control

4.141 Differential pressure transducers should be provided to remotely monitor and alarm on excessive filter pressure drop. In critical areas dirty filter indication lights should be provided at the point of use.

Energy recovery

General requirements

4.142 Energy recovery will normally be fitted to all healthcare ventilation systems. It may be omitted only where it would clearly be uneconomic. Where the economic case is marginal, space should be allowed for the retro fitting of an energy recovery system.

4.143 For systems in healthcare premises, a plate heat exchanger or ‘run-around coil’ system is suitable. Thermal wheels may be used providing they are fitted with a purge sector. The small amounts of air leakage across those devices are not considered significant. Other systems such as heat pumps or heat pipes are also suitable. Selection should be based on relative locations of the supply and extract units, ease of maintenance and practicality. Cleaning access will be required to both sides of any energy-recovery device.

4.144 The following are the minimum energy transfer efficiencies required for devices handling equal air volumes:
Run around coil – 45%;
Plate heat exchanger – 50%;
Thermal wheel – 65%;
Any other energy recovery device – 50%.

4.145 If a plate heat exchanger is chosen, the plates should be constructed of metal. Plastic should not be used for internal bypass dampers and drive gears.

4.146 Whichever energy recovery device is chosen the extract side will need to be protected by a G3 filter and provided with a drainage system as described in Section 4; Paragraphs 4.20 to 4.25, to remove condensate.

Location

4.147 Energy recovery devices should be located downstream of the frost battery and prefilter, prior to the cooling coil or main heater battery on the supply side.

Control

4.148 It is essential to consider the control of both the energy recovery device and the frost battery when assessing the economics of recovery, as all energy provided by the frost battery will directly reduce the heat exchange of the recovery device. To this end, the off-coil setting of the frost coil should be the minimum possible to protect the primary filter; e.g. +2^{o}C.

4.149 The energy recovery device should be controlled in sequence with the main heater battery, and should incorporate a control to prevent the transfer of unwanted heat when the air-on condition rises above the required plant set-point.

4.150 In instances where the plant is cooling the air, it may be possible to remove heat from the supply air at high ambient conditions, under the dictates of enthalpy sensors in the intake and extract ducts.

Attenuation

General requirements

4.151 Noise will be generated in an air distribution system by the fan, plant items and airflow. The ductwork is a very effective transmitter of this noise hence there is generally a need to limit the noise transmission to meet the requirements of the building. This normally involves the provision of sound attenuation treatment as part of the overall ductwork system design.

4.152 A thorough assessment of the design should be made to assess the noise impact. This should take into account the following primary factors:

- fan and plant noise generation;

- air flow generated noise in ductwork fittings and dampers;
- noise generated at grilles, diffusers and other terminals;
- noise break-in and break-out of ductwork;
- cross-talk and similar interference;
- the noise limitations for the building and surrounding areas;
- external noise generation.

4.153 A method of assessment of these factors and the sound attenuation requirements of ductwork systems is given in CIBSE Guide B.

4.154 The fan is usually the main source of system noise. The sound power that it generates varies as the square of the fan pressure, and thus to limit the fan noise level the system resistance should be kept as low as economically possible. As a general rule the selected fan should operate close to its point of maximum efficiency to minimise its noise generation. Where there is disturbance to the airflow at the fan inlet, the manufacturer's stated fan noise levels should be increased by up to 5 dB. More precise guidance on this aspect may be available from the manufacturers.

4.155 Fans radiate noise through both the inlet and outlet connections and it may be necessary to provide attenuation to limit the noise from both of these connections. It is always preferable and more economic to control noise and vibration at source, or as close to source as possible. It should be noted that attenuators offer a resistance to airflow. The resistance must be included in the fan and ductwork calculations.

4.156 Provided care is taken in the design and construction of low pressure systems to avoid significant noise generation in the ductwork, attenuation should only be needed to absorb fan noise.

4.157 Noise break-out from all equipment housed in the plantroom must be taken into consideration if control is to be satisfactory. Any ductwork within the plantroom after the silencer should be acoustically insulated to prevent noise break-in or the silencer relocated at the point of entry or exit of ductwork to and from the plant room.

4.158 There is no complete means of control over external noise generation from such as road traffic, aircraft, factory and community noise. Consideration must be given to this at the design planning stage.

Acceptable types and Location

4.159 The noise levels produced by ventilation and other plant should be reduced by either lining the inside of the duct with sound absorbing material or fitting bespoke attenuator units.

4.160 In supply systems, sound absorbing material should not be applied to the inside surface of a duct system downstream of the final filter, owing to the risk of

mechanical damage and the subsequent dispersal of the media into the ventilation system.

4.161 In supply and extract systems, sound absorbing material must not be applied to the inside of a duct within 1 metre of a fire damper. The material should be non particle shedding and fire resistant (Further guidance can be found in SHTM Firecode suite of documents). Where sound absorbing material is applied in a section of duct that will be routinely exposed during maintenance activities it should be protected from mechanical damage.

4.162 Bespoke attenuator units with a sound-absorbing in-fill suitable for the quality of air being handled and protected by a perforated sheet metal casing are the preferred option for critical systems. Absorption of moisture, dirt and corrosive substances into the 'in-fill' and the release of fibrous particles into the airstream should be prevented by the use of a membrane. The membrane material should have a declared service life of at least 25 years. If these conditions can be met then the attenuator may be located in the supply ductwork downstream of the final filter. When so located cleaning access should be provided at both ends of the attenuator unit.

5.0 Air distribution system

Air distribution arrangements

Ductwork distribution systems

5.1 Ductwork systems for ventilating and air-conditioning applications are referred to by their velocity or pressure category, that is, as low, medium or high velocity or pressure systems. Heating & Ventilating Contractors Association (HVCA) limits are up to 10 m/s or 1,000 Pa; 20 m/s or 1,750 Pa: and 40 m/s or 3,250 Pa in the case of conventional low, medium and high pressure systems respectively. High pressure systems are disappearing because of the constraints of the Building Regulations but existing systems may sometimes need to be altered or extended.

5.2 For normal applications in healthcare buildings, low velocity systems are recommended; and the use of higher velocities than those recommended is not likely to be economical. Future trends are likely to be towards even lower optimum duct velocities; however, velocities below 2.5 m/s are unlikely to be justified.

5.3 The site will often dictate the main routing of ductwork systems, but in general, the design should seek to make the layout as symmetrical as possible; that is, the pressure loss in each branch should be as nearly equal as possible. This will aid regulation and may reduce the number and variety of duct fittings that are needed.

5.4 Main distribution ductwork should not be routed above sleeping areas. Where there is no alternative route, additional acoustic insulation will be required.

5.5 Where auxiliary cooling units, fans, filters or trimming devices are installed in the distribution system, they must be independently supported and fitted with a suitable drainage system where appropriate. If they are a source of vibration they should be linked to the distribution ductwork via flexible connections.

5.6 The fan of a Local Exhaust Ventilation (LEV) system provided under the COSHH regulations should be located outside of the building so that all of the ductwork within the building is under negative pressure. Where the fan has to be within the building it should be located as close as practicable to the outside with an absolute minimum run of discharge ductwork within the building. The discharge ductwork within the building will be under positive pressure so it must not be penetrated by test holes or inspection hatches.

Ductwork materials and construction

5.7 The choice of duct material should take account of the nature of the air or gas being conveyed and the environment in which the duct will be placed.

5.8 Galvanised sheet steel is generally suitable and most economical for normal ventilating and air-conditioning applications. Its inherent mechanical strength renders it resistant to casual damage both during the construction phase and throughout its service life when mechanical and electrical services around it are altered. It also readily withstands the impacts sustained when rotary equipment is used to clean it internally.

5.9 In instances where moisture levels and/or corrosive elements in the air being conveyed are very high, aluminium, stainless steel, PVC or GRP ducts should be used. Stainless or black steel are the only suitable materials for high temperature ductwork.

5.10 In inherently wet areas, such as the base of fresh air inlet ducts and some extract systems, the ductwork may require draining to prevent a build up of standing water. The layout of the drains should be as specified in Section 4 Clauses 4.20 to 4.25.

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5.11 Where builderwork plenum chambers or ducts are used, these may be constructed of various materials. However all such ducts must be rendered and sealed to prevent dust shedding. A greater allowance may need to be made for leakage.

5.12 Galvanised, black and stainless steel ductwork should be manufactured and installed to DW144 – HVCA specification for sheet metal ductwork, but excluding the use of bolt-through supports.

5.13 GRP and PVC ductwork should be manufactured and installed to DW154 – HVCA specification for plastic ductwork.

5.14 Phenolic board ductwork is unsuitable for use in healthcare applications and should not be used.

5.15 Flexible duct work is unsuitable for air distribution in healthcare applications. It should only be used to make the final connection to a terminal (See clauses 5.54 and 5.55).

5.16 The inside of the ductwork should be free from structural projections and as smooth as possible. Flanged, gasketed joints are preferred.

Fire aspects, damper types and locations

5.17 It is essential that all relevant fire aspects of ducting systems are agreed with the fire officer before the design is finalised.

5.18 Ductwork must be fire-stopped where it penetrates fire compartment walls, floors and enclosures, cavity barriers and sub-compartment walls or enclosures, and provided with weatherproof collars where roofs or external walls are penetrated.

5.19 Fire/smoke dampers shall be provided at the locations required by Firecode. The fire damper mounting frame must be securely attached to the building fabric. Where a fire damper is not mounted directly in a fire compartment wall, it

must be correctly supported and the ductwork between it and the fire wall must posses the same fire rating as the fire wall that it penetrates. The fire rated portion of ductwork must not be penetrated by test holes or inspection hatches. All fire/smoke dampers shall be capable of remote re-setting via the Building Management System or equivalent, after periodic testing procedures.

5.20 An access hatch shall be provided adjacent to each fire damper so that its correct operation can be directly observed.

5.21 Smoke-diverting dampers must be provided on recirculation air systems to divert automatically any smoke-contaminated return air to the outside of the building in the event of a fire; and arranged so that the normal open smoke-diverting damper on the return air branch to the input unit closes and all the return air is exhausted through the extract fan. Guidance is available in SHTM 81 and BS5588: Part 9.

Duct sections

5.22 Ducting is generally available in rectangular, circular and flat oval sections, although other sections may be made for special situations.

5.23 Rectangular ducting is most common on low pressure systems, for the following reasons:

- it can readily be adapted to fit into the space available;
- fittings are cheaper than those for circular or flat oval ductwork;
- it can readily be joined to such component items as heating and cooling coils, and filters.

5.24 When sizing ductwork, the designer should take into account:

- both installation and operating costs;
- space limitations imposed by the structure and other services;
- operating noise levels;
- requirements of regulation at the commissioning stage.

5.25 For overall economy and performance, the aspect ratio should be close to 1:1, since high aspect ratios increase the pressure loss, heat gains or losses and overall cost (for example, changing the aspect ratio from 1:1 to 1:4 can typically increase the installed cost of the ductwork by 40% and add 25% to the heat gains or losses).

5.26 Rectangular ducting should not be the first choice for high pressure systems, and should be avoided in systems operating at high negative pressures, because the strengthening of the flat sides and the sealing requirements necessary to make rectangular ducts suitable for these high pressures are costly.

5.27 Circular ducting is preferable for high pressure systems; and for systems operating at high negative pressures. In the case of the latter, additional stiffening rings may be necessary. Machine-formed spirally-wound ducting and a standard range of pressed and fabricated fittings can sometimes make circular ducting more economical, particularly in low pressure systems having a relatively low proportion of fittings.

5.28 Flat oval ducting provides an alternative to circular ducting, principally where there is a limitation on one of the dimensions in the space available for the duct run.

5.29 Other sections may be used, such as triangular sections to pass through roof trusses. Such sections present difficulties in the provision of fittings, and connections to standard plant items, and are likely to be more expensive than traditional sections.

Standard ductwork fittings

5.30 All fittings should conform to DW144. Wherever possible, long radius bends, large radius main branches, not more than 45^{o} angle sub-branches and long taper transformations shall be used.

5.31 Fittings should be arranged with vanes in sub-branches connected directly to grilles and diffusers, and turning vanes in square bends (when used). When vanes are used, additional cleaning access will be required.

5.32 The number of duct fittings should be kept to a minimum and there should be a conscious attempt to achieve some standardisation of types and sizes. Increasing the number and variety of fittings in a system can markedly raise its overall cost.

5.33 Bad design in relation to air flow can lead to vibration of flat duct surfaces, increases duct-generated noise and pressure loss, unpredictable behaviour in branch fittings and terminals, and adverse effects on the performance of installed plant items, such as trimmer batteries.

Branches

5.34 There are many designs of branches and junctions in use. The important features are that the flow should be divided (or combined) with the minimum interference and disturbance. Changes in duct sizes should not be made at the branch but a short distance downstream (or upstream). A good dividing branch design cannot be effective if the flow entering the branch is not uniform across the section.

Changes of section

5.35 The expansion of a duct section should be formed with sides having a total included angle of no more than 30^{o}, and preferably less than 20^{o}. If the angle of expansion is greater, the flow is not likely to remain attached to the walls of the duct and large eddies will be formed with flow reversal at the walls. This leads

not only to a high pressure loss, but also to non-uniform velocity pattern at the outlet. Where there is insufficient space for a gentle expansion and a greater angle is necessary, internal splitters should be used.

5.36 A contraction in a duct section is less critical, but the total included angle of the taper should not exceed 40^{o}, or 20^{o} where the contraction is made on one side of the duct only.

5.37 The most economical way to change the section of a rectangular duct is to restrict the change of duct size to one side only. If the calculated reduction or increase to the side dimension is 50mm or less, it is usually not economical to change the size at the position. The minimum size of a rectangular duct should usually be 150 mm x 100 mm.

Other fittings

5.38 As a general rule, fittings should avoid abrupt changes in direction and sharp edges which cause the flow to separate and form eddies, thus limiting pressure loss and noise generation. If the fitting leads to the flow preferentially attaching to one side of the outlet, then a significant length of straight downstream duct is necessary before the next branch or fitting; this length should be greater than five equivalent diameters.

Thermal insulation

5.39 Thermal insulation is applied to ductwork to reduce heat exchange, and to prevent condensation.

5.40 In a duct system, the air temperature changes can be significant, especially when passing through untreated space, and these have the effect of reducing the heating or cooling capacity of the air and of increasing the energy input to the system. The heat transmission to and from the surrounding space can be reduced by effective insulation of the ducts.

5.41 Condensation can arise in ductwork systems conveying cooled air and, apart from creating conditions conducive to corrosion of ductwork, condensation affects the heat and vapour-resisting properties of insulating materials themselves which may induce further condensation.

5.42 In normal circumstances, the insulation thickness for heat resistance is sufficient to prevent surface condensation, but in extreme conditions the insulation thickness for vapour resistance may be greater than that for heat resistance. When cold ducts pass through areas of high dew-point, carefully selected vapour barriers should be applied externally to the insulation.

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Noise generation within the ductwork

5.43 Noise is generated in ductwork at sharp edges, by tie rods, damper blades, duct obstructions and sharp bends etc. This air flow-generated noise becomes an important factor if it is about the same or greater level than the upstream noise level. Air flow-generated noise is often referred to as re-generated noise.

5.44 The noise level generated by air flow in ductwork is very sensitive to the velocity. The sound power of this noise is approximately proportional to the sixth power of the velocity; that is, a doubling of the duct velocity will increase the sound power by a factor of 64. The duct velocities should therefore be kept as low as possible. In general, duct fittings which have lower pressure loss factors in similar flow conditions will generate less noise.

5.45 Ductwork serving quiet areas should not be routed through noisy areas where noise break-in can occur and increase the noise level in the ductwork.

5.46 Grille register and louvre noise should be kept to the minimum by selecting types having low noise-producing characteristics, without high tonal noise; and should be fitted with acoustically treated external inlet and outlet louvres.

5.47 Cross-talk attenuators may be necessary where noise intrusion between adjacent spaces can arise and where individual room confidentiality is required. They will normally be of the 'through-the-ceiling, 'up and over' type and may include a fire damper if required.

Volume control damper locations

5.48 Manually operated balancing dampers are needed generally:

a in the main duct downstream of the fan;

b in branches of zone ducts;

c in sub-branch ducts serving four or more terminals;

d at terminals not covered by (c) above.

5.49 Dampers integral with terminals should only be used for final trimming of air volumes, or noise and air distribution problems may ensue.

5.50 Dampers in rectangular ducts should be single-bladed when the longer side is up to 450 mm and opposed-blade multi-leaf type above this size. In circular ducts, iris-type dampers are recommended. Dampers must be accessible, incorporate a position indicator and means of locking in the commissioned position. Dampers should be located as far away as possible from adjacent branches or plant items.

Access door locations

5.51 Access doors are required to facilitate access to plant items and ductwork components for inspection, maintenance, cleaning and replacement, and must be of sufficient size to permit safe access for the required functions.

5.52 Recommended locations for access doors are given in DW144 and are generally provided to give access to:

- every regulating damper;

- every fire and motorised damper;
- filter (to facilitate filter withdrawal);
- both sides of cooling/heating coils;
- humidifiers;
- fans and to provide access to motors and impellers.

5.53 Care should be taken when siting access doors to ensure that no other services to be installed will prevent reasonable access.

Flexible ducting

5.54 Flexible ductwork may be used for final connections to grilles and diffusers provided it is constructed to meet the fire precautions recommended in BS8313. It must not pass through fire compartment walls, floors or enclosures of sub-compartment walls or enclosures, or through cavity barriers.

5.55 Flexible ducting will cause a significant frictional loss and may be difficult to clean, it should never be used in lieu of a bend. Where installed it should take the most direct route and be as short as possible, never exceeding 1 metre in length.

Diffuser and grille selection and sizing

5.56 The effectiveness of all ventilation and air-conditioning systems depends on the methods by which air is introduced to, and vitiated air is removed from, the space. The usual results of poor air terminal selection and/or positioning are; draughts, stagnation, poor air quality, large temperature gradients and excessive noise.

5.57 Air can be supplied to a space in a number of ways, although any device can be broadly placed into one of two categories; that producing a diffused supply, or that producing a perpendicular jet. Diffusers may be radial or linear, and normally utilise the Coanda effect (that is, adhesion of the air stream to an adjacent surface), to reduce the risk of excessive room air movement. A perpendicular jet is formed by discharging air through grilles, louvers or nozzles, which are generally adjustable.

5.58 Airflow patterns produced by both types of terminal are dependent to a large extent on the presence of the Coanda effect.

5.59 Supply air terminals can be incorporated into any room surface, for example, floors, walls (high or low level), desktop etc.

5.60 As they operate on the jet principle, the use of sidewall and linear grilles is restricted to areas where air change rates are low, that is, less than 10 per hour. Perforated rectangular diffusers can provide acceptable conditions within the occupied zone at up to 15 air changes per hour. In areas where a higher air change rate is required, square or circular ceiling mounted diffusers should be used.

5.61 The performance of supply air terminal devices is provided, based on three criteria; throw, spread and drop. Throw is defined as perpendicular or parallel distance from the terminal to the point at which the air velocity is 0.5 m/s isovel. Spread is defined as the width of the 0.5 m/s isovel; and drop is defined as the vertical distance from the centre line of the terminal to the bottom edge of the 0.25 m/s isovel.

5.62 It is necessary to consider each of these parameters in both summer and winter conditions to ensure satisfactory operation of the air terminal device, as warm jets behave very differently from cold jets.

5.63 A warm jet tends to rise until it attaches itself to a horizontal surface, while a cold jet falls. Care must be taken to ensure that this does not lead to unacceptable temperature gradients in winter, or excessive air velocities in the occupied zone in summer.

5.64 In order to ensure satisfactory air movement within a space, it is necessary to consider interaction between air movement from adjacent terminals, and ceiling mounted fixtures (light fittings etc), as well as interaction between air movement and room surfaces.

5.65 If the supply and extract terminals are too close, short-circuiting may occur, while if they are too far apart, stagnant zones may be formed. Where two opposing air streams meet, the individual velocities must not be greater than 0.25 m/s.

5.66 Supply and extract grilles and diffusers should be fitted with opposed-blade dampers for fine balancing purposes.

5.67 Further guidance on the selection of grilles and diffusers is given in the CIBSE Guide B.

5.68 In operating theatres, the supply terminals must be able to produce a down flow movement of air in the operating zone 1 metre above floor level. Ceiling mounted diffusers with fixed directional vanes that provide a downward turbulent airflow are the preferred option. Plenum boxes fitted with perforated screens to produce a laminar down are also acceptable. Nozzles or jets of any type are not acceptable. Sidewall mounted linear diffusers that utilise the coanda effect to send air across the ceiling and 'drop' it into the operating zone are also not suitable. However linear ceiling mounted diffusers that provide a direct downward airflow around the operating zone may be used.

Transfer grille - size and location

5.69 Air transfer grilles in walls, partitions or doors form an integral part of the building's air distribution system. Modern door sets have very low leakage rates so cannot be relied upon to permit even quite small airflows. Failure to make adequate provision for air to move from room to room will result in excessive pressure differentials and 'door whistle'.

5.70 Transfer grilles are required in locations where there is a significant imbalance between the supply and extract rates in a room. They will relieve any pressure differentials which may affect the operation of the spaces and/or the ventilation system and permit airflow in a known direction. However, transfer grilles are vulnerable to damage and, in many instances, provided the equivalent free area is provided, they can be substituted with undercut door.

5.71 Care needs to be taken to ensure that the positioning of transfer grilles does not interfere with the fire or smoke integrity of the building. In general, the air transfer grilles should not be installed within fire-resisting boundaries, although if this is unavoidable, they should be fitted with fire or smoke dampers.

5.72 Where installed, transfer grilles should be of the non-vision type, sized for a maximum face velocity of 1.5 m/s.

5.73 In photographic dark rooms, lightproof transfer grilles will be required.

5.74 Cross-talk attenuators may be necessary where noise intrusion between adjacent spaces can arise and where individual room confidentiality is required. (See also paragraphs 5.43 to 5.47).

Pressure stabilisers - size and location

5.75 Pressure stabilisers are required in lieu of air transfer grilles in areas where it is necessary to maintain pressure differentials between adjacent rooms to prevent reversal of air flows for example, in operating suites, isolation facilities and clean rooms. (See also Section 7 paragraphs 7.24 – 7.28).

5.76 Fire precautions for pressure stabilisers are the same as for transfer grilles. For sizing criteria, refer to Section 7 paragraph 7.23

5.77 Pressure stabilisers should be of the balanced blade type, with the facility to make fine adjustment of the pressure setting. They should be silent in operation and give a seal as tight as practicable when closed. The materials of construction and method of assembly should allow for cleaning and disinfection.

5.78 Pressure stabilisers should be installed in a visible location so that their operation can be readily observed.

5.79 Cross-talk attenuators may be necessary where noise intrusion between adjacent spaces can arise and where confidentiality is required. In these cases, the pressure stabiliser and cross-talk attenuator should be mounted in a short length of ductwork within the ceiling void.

5.80 Pressure stabilisers may need to be fitted with a stand-off baffle on their discharge side to prevent a sight line in situations where a laser will be used. Baffles may also be required to preserve privacy or prevent discharge air causing draughts or disturbing the air distribution pattern in the adjoining room. They are also useful in low-level locations to prevent the air-flow path being obstructed by protable equipment.

6.0 Automatic controls

6.1 Various options for control of single and multi-zone air-conditioning systems are given in CIBSE Guide B.

General requirements

6.2 The basic requirements for an automatic control system are as follows:

- facilities to start, set-back and stop the plant;
- facilities to control the volumetric air flow;
- facilities to control the system or room pressure;
- temperature control and indication;
- humidity control and indication;
- devices to monitor and indicate the plant operating state;
- alarms to indicate plant failure, low airflow, and filter state.

The control functions actually provided will depend on the purpose of the ventilation system.

6.3 There will also be a need to determine the control strategy in the event of a fire either within the zone being served or within an adjoining zone.

6.4 The designer should consider whether it is necessary for the supply and extract fans to be interlocked, either so that the supply fan will not operate unless airflow is established within the extract system, or vice-versa depending on the required pressures within the rooms being served.

6.5 The sequence switching of units in order to prevent transient reverse airflows will be particularly important in laboratory and pharmacy areas that also contain fume cupboards, safety cabinets and other LEV systems.

6.6 Alarms should be provided to show 'filter fault' and 'low air flow'. The "filter fault" alarm should be initiated by a predetermined increase of pressure differentials across the filter. The 'low air flow' alarm should be initiated when the supply air quantity falls to 80% of the design value.

Objectives of control system

6.7 The primary objective of ventilation plant control system is to maintain the space served within the required environmental control limits, at the appropriate times, regardless of external conditions or internal loads and with the minimum energy consumption.

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6.8 Often, it is not possible to predict accurately building load variation at the design stage, and thus optimum set points cannot be assessed. Information provided by monitoring the operation of the plant via a Building and Energy Management System (BEMS) will enable optimum set points to be established and energy consumption reduced. Control of most systems will be via a BEMS. This will enable the operating conditions and control tolerances to be set and monitored. Often, it is not possible to predict accurately building load variation at the design stage. Information provided by monitoring the operation of the plant via a BEMS will enable optimum set-points to be established and energy consumption reduced. The BEMS may also be set to log the actual energy consumed by the system together with that recovered by the energy-recovery device. This will provide a useful check on overall operating efficiency and provide evidence that energy targets are being achieved.

6.9 BEMS incorporating self adaptive control algorithms that automatically adjust the set point to the suit the usage and load are preferred. The provision of movement sensors within the controlled space in order to determine the actual occupancy will facilitate this process.

6.10 The failure of specialised ventilation systems can have grave consequences for the delivery of healthcare. Control systems should therefore be simple, robust and reliable.

6.11 Computer software driven control systems are becoming the norm in building services. However, it should be remembered that healthcare ventilation systems will need to be available to operate outside of normal working periods when software support is not available. Should the software fail, it will be left to site staff who may have little knowledge of the control algorithms to restart the ventilation system. It is therefore essential to ensure that systems can be manually started in the event of a software failure is provided (see also the comments in Section 4; paragraphs 4.62 to 4.63).

Location of controls

6.12 Whether within the plant, duct or room, sensors should be located to provide accurate measurement of the condition of the air being monitored.

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6.13 Sensors and control items such as control valves should be located close to the element being sensed or plant item being controlled, in order to minimise time lags within the system which may create over-shoot of conditions beyond the design envelope and result in additional energy consumption.

6.14 There are practical advantages in locating all control valves for an Air Handling Unit in a bank at a convenient height at one end of the unit. This will not normally result in an undue additional control lag.

6.15 Some applications require intermittent mechanical ventilation, frequently at a high air change rate, for example, in bathrooms and treatment rooms. Local controls to facilitate this mode of operation should be placed in a prominent position to encourage economical use.

6.16 Local controls that enable the user to select more than one mode of operation should be clearly labelled to identify the particular mode selected. Where the system allows different room pressures to be selected then a direct reading pressure gauge should be fitted within the eye line of the users to provide an independent confirmation of the resultant mode of operation. A clear description of the selectable modes of operation should be mounted adjacent to the control switch.

Fire aspects

6.17 A fire control panel should be mounted at the entrance of the area that the ventilation serves. The panel should have restricted access for the fire officer and include independent on/off control and indication of the supply and extract.

6.18 In certain critical care departments it is preferable to maintain the supply ventilation in the case of a fire within the area. For example in an operating department while undergoing surgery the patient cannot always be easily moved without significant risk. In the event of a fire in a staff or support area of the department, or adjoining zone the continued supply of air to a theatre will maintain it at a positive pressure and protect the patient and staff from the effects of smoke. This will allow time for the patient to be stabilised so that they can be safely evacuated if necessary. A similar situation occurs for patients in ITU and other critical care units. In all of these cases the ventilation to the critical area should continue to operate unless the AHU starts to draw in smoke. For these departments, a notice should be affixed to the fire control panel drawing attention for the need to liaise with departmental staff before switching fan units.

6.19 All supply AHUs should have a smoke sensor mounted in the main supply duct immediately downstream of the AHU. In the event of a fire in the AHU or smoke being drawn into the system from an outside source, it should cause the supply air fire damper to close and shut down the AHU.

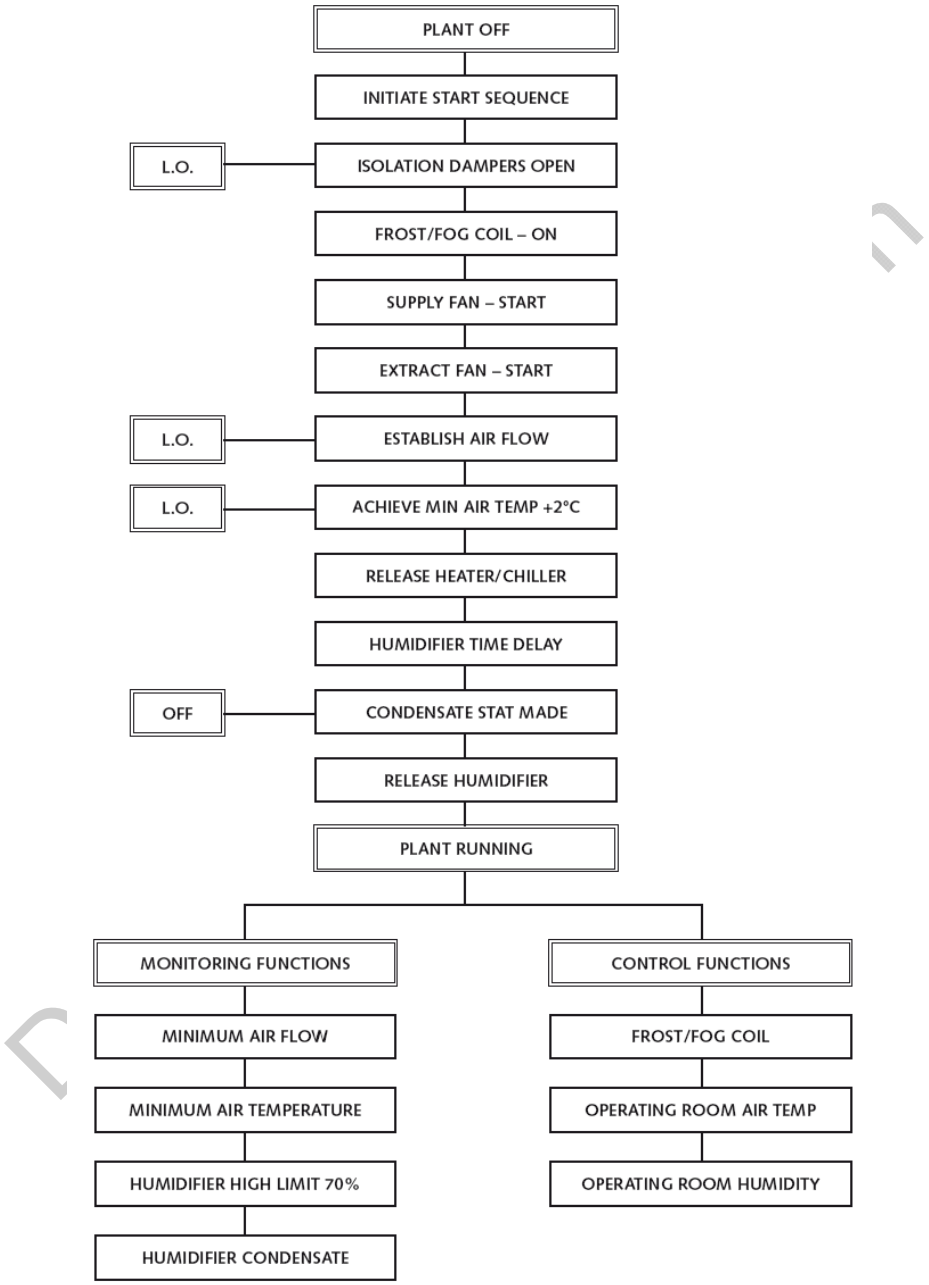
Time switching

6.20 Facilities to start, set-back and stop the plant should be provided in the plantroom. Remote start and set-back control and indication, if required, should be provided at a manned staff location, for example, at the reception or staff base or, in theatres, within the Surgeon's Panel.

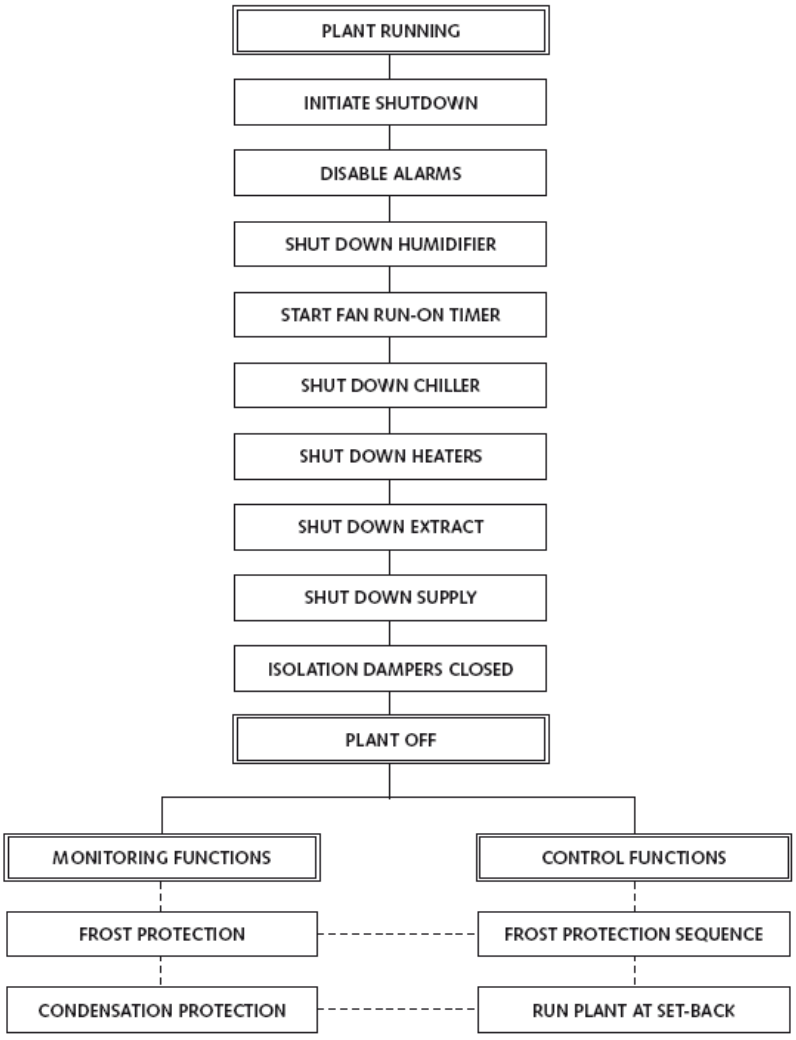
6.21 Many ventilation systems may be completely shut down when the area serve is not in active use. Alternatively, where there is a need to maintain a background condition, the ventilation output can be reduced by "setting back" the system. This will significantly reduce energy consumption and extend the life of filters and other system components.

Start-up control

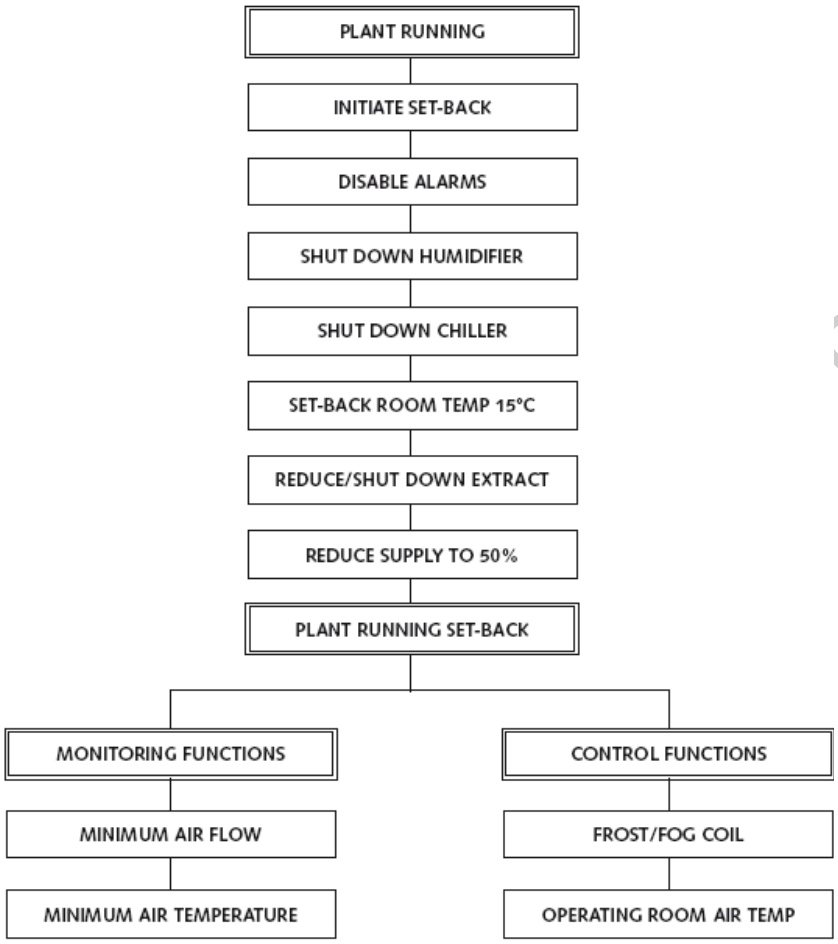
6.22 The plant start control should contain a control logic that will start the plant in the sequence set out in the following algorithms.



Typical plant control algorithm – normal start-up sequence



Plant control algorithm – normal shut-down sequence



Plant control algorithm – set back sequence

Set-back control

6.23 Where variable speed controls are installed, the set-back facility for each plant should depress the control temperature to around 15°C; exclude any humidification and cooling from the system; and reduce the supply and extract air volumes to around 50%. The extract fan can also be turned off as long as the desired direction of air movement from clean to less clean will be maintained (See also the previous algorithms).

Use control

6.24 The installation of movement detectors allows for 'use control' of ventilation systems. A simple control logic that reduces the system to a 'set-back' condition if there has been no movement detected in the space for, say, 30 minutes and

that switches the system 'off' if no movement is detected for one hour is recommended for many applications, including operating suites.

6.25 A variation on this can be provided by linking ventilation controls to lighting. For example, in an operating theatre, the system may be off outside of working hours, could run at set-back when the general lighting was switched on and increase to full speed when the operating lamp is switched on. As with movement detection, a 30-minute run-on should be provided at each stage when the lights are turned off.

6.26 Either of the above control strategies may be refined by linking to the BEMS to provide a control logic related to normal working hours and associated 'real-time' movement within the zone being controlled. This should result in significant energy savings.

Environmental control

Temperature control methods and application

General

6.27 All control valves must fail safe, that is, close in the event of power or air-flow failure, with the exception of the fog/frost battery control valve, which should open upon power or air-flow failure.

6.28 Control valves should be located in an accessible position. Isolation valves should be provided to enable the control valve to be removed for service without the need to drain down the system.

6.29 Care should be taken to ensure that the installation of control valves and their associated pipework do not obstruct access to the AHU inspection doors and hatches.

Room temperature control

6.30 The limits for room temperature set point are generally between 16°C and 25°C depending on the particular application; and in some specialised instances (for example, operating departments) are adjustable within a predetermined range by the user.

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6.31 The selection of temperature set point for each room or zone, may be by a control facility in the room / zone, or remotely at the control panel or BEMS. Where the control device is mounted within the room / zone and adjustable by the user, it should be marked either 'raise' and 'lower' or '+'and'-'. It should control within a specified temperature range to suit the user requirement with a control tolerance of ±1°C. All other control set points should be selectable either on the control panel or at the BEMS interface.

6.32 Where local control is provided, an indication of temperature will be required locally, or at a staff base (if appropriate), using an analogue or digital indicator. The indicator should be large enough to be read from the normal working position. e.g. at the operating table in a theatre. This may be mounted in a

supervisory control panel, with the signal repeated on the main system control panel or BEMS. It is important that this indicator displays the actual measured temperature and not the selected temperature.

6.33 Where the supply and extraction system are designed for ventilation only and there is a wet heating system providing background heating care must be taken to ensure one system is trying to heat the space while the other system is trying to cool the area. Synchronising the systems is essential.

Frost battery control

6.34 Steam supplied frost batteries must be operated as on/off devices with their sensor mounted upstream of the battery. This will give 'open loop' control; a set point of +1^{o}C is recommended.

6.35 Low pressure hot water (LPHW) supplied frost batteries should be controlled using the Proportional mode. Their sensor should be located downstream of the battery to give 'closed loop' control. A set point of between 2^{o}C and 5^{o}C is recommended.

6.36 If the temperature downstream of the frost battery, as sensed by a serpentine thermostat, falls below the required set point over any part of the coil, the plant must automatically shut down in order to prevent damage to the other batteries. The serpentine thermostat must not be in direct contact with the coil.

Off-plant control

6.37 The control logic must prevent the chiller and pre-heater being on at the same time.

Humidity control methods and application

6.38 In order to prevent excessive condensation when starting up from a total plant shut-down, a time delay should be incorporated into the control system such that the humidifier does not start until 30 minutes after the ventilation plant start-up.

6.39 Irrespective of the method of control, a high-limit humidistat should be installed to ensure that when the humidifier operates, the condition of the air in the duct does not exceed 70% saturated, particularly during plant start-up.

6.40 With certain types of steam humidifiers, it may be necessary to install a thermostat in the condensate line from the humidifier's steam supply, to ensure that the steam at the control valve is as dry as possible before it is injected into the air supply.

6.41 The humidifier and cooling coil control must be interlocked so that they cannot be on at the same time.

6.42 The humidifier control system should ensure that it is switched off with the fan. It is preferable to design the control system so that the humidifier is isolated for

an adequate time before the fan is turned off so as to purge humid air from the system.

6.43 All control valves must fail safe, that is, close in the event of power failure, and the humidifier must be interlocked with the low air-flow switch.

Multi-zone control methods and application.

6.44 Close control of all air-conditioning parameters may be difficult to achieve with multi-zone systems, since each zone will in theory require a reheater and humidifier to give total control of humidity if that is what is required. In reality such close control is rarely required in practice. It is therefore usual with multi-zone systems to provide control of zonal temperature only, with humidity control where fitted being based on average conditions within all zones, or minimum conditions within one zone.

6.45 Where there is a requirement for close control of air-conditioning parameters in a number of zones, e.g. an operating department, separate plants should be provided for each zone in order to avoid the need for expensive over-cooling and reheating of individual zones.

6.46 Most multi-zone systems within healthcare premises are controlled based on off-coil control within the central plant, with trimmer heater batteries on individual zones.

Alarms and indication

6.47 Supply and extract systems should include indicator lamps on the control panels to confirm the operational status of each system. Where the usage is on a regular daily pattern, time control with a user operated timed manual over-ride should be provided.

6.48 Where a system is provided for a particular space, the indicator should be in, or immediately adjacent to that space and local controls should be provided with labels clearly defining their function eg. isolation suites.

6.49 The ‘plant failure’ and ‘low airflow’ alarm should be initiated by a paddle switch or other device located in the main air supply duct. This should operate when the air quantity fails to reach or falls to around 80% of the design value and will give indication of fan failure, damper closed, access door left open, or any other eventuality that could cause a reduction of air quantity. Monitoring the current drawn by the fan motor is not a substitute for a sensing device that is directly affected by the airflow.

6.50 The ‘filter fault alarm’ should be initiated by a predetermined increase of pressure differential across the filters, thereby indicating a dirty filter.

6.51 Direct reading gauges or manometers should be installed across filters to give maintenance staff an indication of their condition.

Deleted: *Inclined gauge*

6.52 Visual indication should be provided at a manned staff location, for example, the reception or staff base, and on the main control panel and BEMS to show ‘plant failure’ and ‘low airflow’.

BEMS

6.53 Control of most systems will be via a Building Energy Management System. This will enable the operating conditions and control tolerances to be set and monitored. The BEMS may also be set to log the actual energy consumed by the system and recovered by the energy recovery system. This will provide a useful check on the overall operating efficiency and provide evidence that energy targets are being achieved.

7.0 Specialised ventilation systems

7.1 This section contains design information for a range of healthcare ventilation applications.

7.2 The following departments will require a degree of specialised ventilation.

The Operating department:

- treatment rooms;
- endoscopy, daycase and minimum invasive suites;
- cardiology and operative imaging suites;
- conventional operating theatres;
- Ultra Clean Ventilation (UCV) operating theatres;
- barn theatres;
- recovery and ancillary areas.

Obstetrics:

- maternity theatre;
- delivery room;
- LDRP Room;
- SCBU.

Isolation facilities

- infectious disease unit;
- bone marrow and other transplant units;
- chemotherapy and oncology units.

Sterile Supply and Disinfection Units:

- wash room;
- packing room;
- sterile pack store.

The Pharmacy department:

- aseptic suite;
- extemporaneous preparation area;
- radio pharmacy.

The Pathology department:

- laboratories;
- cat 3 and 4 rooms.

The Mortuary and Post mortem suite:

- mortuary;
- post mortem room;
- specimen store.

Hydrotherapy unit:

Burns unit:

- burns theatre;
- treatment room;
- isolation room;
- tissue bank.

Emerging specialties:

- gene therapy unit;
- stem cell laboratory.

Infrastructure:

- plant rooms housing combustion equipment;
- welding facilities;
- wood working workshop;
- electric vehicle charging area.

7.3 Design information for many of these applications is given in Appendix 1 Table 1A and in the following Chapters within this section.

7.4 It is not possible within this existing document to give definitive guidance for every healthcare specific ventilation application. Additional detailed guidance may be issued in due course in the form of supplements.

General information

7.5 The section on operating theatres is the most extensive and contains much information that is common to other applications. Where no specific guidance is given then the principles set out below should be followed:

- the foregoing sections of the document contain general information on Healthcare specific aspects of ventilation system design and specification;

- a set of standard solutions for the design of general operating theatre suites to conform to past and new standards is given in new standard layouts Nos 1, 3, 5 and 7 and those for UCV theatres in new standard layouts Nos 2, 4, 6 and 8 within Appendix 3;
- the CIBSE Guide A & B contains basic information on ventilation design that can be applied to most applications;
- where a British or European standard exists that is specific to the application, e.g. a clean room, it should be used as the basis of the design requirement;
- air should always move from clean to less clean areas. A hierarchy of room cleanliness is given in Appendix 2 Table A2;
- differential pressure will prevent contamination between areas when doors are closed. Information on air leakage through closed doors and hatches for a range of differential pressures is given in Appendix 2 Table A3;
- the flow of air will prevent contamination between areas when doors are open. Information on air leakage through open doors and hatches for a range of differential pressures is given in Appendix 2 Table A4;
- if anaesthetic gases are used, 15 air changes per hour will be required;
- a methodology for calculating a design solution for a non standard suite of operating rooms is given in Appendix 4. This may be adapted as necessary to suit other less complex applications where air is required to cascade from clean to less clean areas.

7.6 The supply of air to a room has four main functions:

- to dilute airborne contamination;
- to control air movement within such that the transfer of airborne contaminants from less clean to cleaner areas is minimized;
- to control the temperature and if necessary the humidity of the space;
- to assist the removal of and dilute waste gases where used.

7.7 Because of the complexities of controlling air movement patterns, much design effort will be required for this aspect. It is important that the design makes the best possible use of the air available, as excessive supply air flows for the control of air movement should not be used. The amount of air supplied will be determined by the number of doors and desired air change rate.

7.8 There are four routes that airborne contaminants may appear in a room:-

- Through the supply air;
- Shed directly by the room occupants;
- Arising as a result of the work activities;
- Transferred from adjacent spaces.

7.9 Particles entering with the supply air can be controlled by the selection of suitable filter grades.

7.10 Particles shed directly by the room occupants can be controlled by:

- restricting access to essential persons only;
- the choice of the occupants clothing;
- the room air change rate.

7.11 Particles arising as a result of the work activity can be controlled by:

- enclosing, semi-enclosing or otherwise controlling the work based source;
- the room air change rate.

7.12 The transfer of particles from adjacent spaces can be controlled by:

- differential pressure;
- airflow paths.

7.13 Air change rates are given in Appendix 1 Table A1. These figures have been found to give sufficient dilution of airborne contaminants, provided the mixing of room air is reasonably uniform.

7.14 A downward displacement turbulent air distribution is generally preferred. The supply and extract diffusers should be positioned to ensure that all parts of the room are actively ventilated and that where necessary the staff will be in a clean air flow path. (See Section 5 for additional guidance on supply terminals).

7.15 Horizontal flow room air distribution with or without a Coanda effect can be a source of draughts and difficult to set up correctly. Its use should be confined to non critical areas.

Air movement control

7.16 The design of the system should seek to minimise the movement of contaminated air from less clean to cleaner areas. Transfer grilles enable air to pass in either direction between rooms of equal class and pressure. Pressure stabilisers operate in one direction only, they allow excess air to be directed to the area desired and assist in maintaining room pressure differentials. When closed they prevent significant reverse air flow.

7.17 The relative locations of supply and extract terminals and their design air volume rates will determine the basic air flow between adjacent spaces. Transfer grilles and pressure stabilisers will permit and control the flow of air between spaces ensuring a flow from the clean to less clean areas. Failure to provide such devices will lead to uncontrolled air flows when personnel move between rooms. They may also result in doors being held partially open by air pressure.

Temperature and humidity control

7.18 Supply flow rates to achieve the required room conditions, are calculated conventionally, taking account of all heat and moisture gains and losses, and of maximum permissible temperature differences between the room and supply air. In most applications the base heating load will be provided by a heating system. In critical systems the room or suite being considered will be within the heated building envelope so the ventilation will be sized to suit the casual gains or losses.

7.19 Temperature differences of up to 10K for winter heating and 7K for summer cooling must not be exceeded.

7.20 It is acceptable for the humidity to swing uncontrolled between 35% and 60% saturation.

Removal and dilution of waste anaesthetic gases

7.21 Anaesthetic gases are subject to occupational exposure limits. Waste anaesthetic gas must be contained and removed by a suitable gas scavenging system. Some leakage from the anaesthetic equipment and the patient's breathing circuit will occur with all systems, particularly during connection and disconnection; and from the interface with the patient. The air movement scheme should ensure that this leakage is diluted and removed from the room. Anaesthetic agents are heavier than air so placing the supply terminal at high level with an extract at low level adjacent to the anaesthetic gas terminal units will ensure that staff are in a clean air flow path.

7.22 In LDRP and delivery rooms the use of anaesthetic gas is controlled on demand by the patient. This may result in significant leakage which, in order to reduce staff exposure, will need to be controlled by establishing a clean air flow path. A supply at high level at the foot end of the bed with extract at low level at the head end will provide such a path.

Fire aspects

7.23 When considering the overall air-flow movement, careful thought needs to be given to the operation of the ventilation system, to limit smoke spread in the event of a fire.

Door protection

7.24 Air should flow from the cleaner to the less clean areas as shown in Appendix 2 Table A2. There are several factors that affect the likelihood of a reverse air flow through doorways:

- when a person passes through a doorway, both the passage of the person and the movement of the door flap cause a transfer of air between the areas separated by the door;

- when a door is left open there is a transfer of air between the two areas separated by the door way. This is caused by air turbulence, but is greatly increased by any temperature differential between the areas (a 1.4 m wide doorway may allow the transfer of 0.19 m^3/s of air in each direction when there is no temperature difference, but when the temperature differential increases to say 2K, the volume transferred may increase to 0.24 m^3/s).

7.25 Two methods of door protection are used in order to reduce the likelihood of contamination of clean area by a reverse airflow from a less clean area:

- closed door protection – A pressure differential is created across a closed door so that any air leakage is from the clean to the less clean area. Appendix 2 Table A3 gives details of closed door leakage rates for a range of differential pressures;
- open door protection – The pressure differential drops (See Appendix 3 Table A5) and is effectively replaced by a flow of air through the doorway from the clean to the less clean area. The flow of air needs to be sufficiently large to ensure that significant reverse airflow cannot occur and will be related to the relative cleanliness of the areas being considered. Appendix 2 Table A4 gives airflow rates for open door protection related to door / opening size and classification of the adjoining areas.

7.26 Pressure stabilisers enable the room differential pressure to be set when the doors are shut, thus providing closed door protection. When a door is opened the stabilisers will close forcing air to be directed through the doorway thus providing open door protection.

7.27 The recommended airflow rates to achieve this are given in Table A3. Provided that the dilution criteria in Appendix 1 Table 1A are met, the occasional small back-flows created (when two doors are opened simultaneously; or when there is a high temperature difference across an open door) will have little effect on the overall air cleanliness of the affected room.

7.28 In applications where it is critical to maintain a specific air flow and /or pressure regime, for example isolation rooms, all windows in the zone should be locked shut or sealed. Trickle vents, if fitted, will also need to be sealed.

Systems design

7.29 The design of the ventilation system for an area depends on the overall configuration of the department. Where the department is served by more than one AHU the control of the units may need to be interlocked so that reverse airflow patterns do not occur.

7.30 Dual-duct high velocity systems have advantages, but are noisy, costly and may give rise to unacceptable values of humidity. Single-duct, low velocity/pressure systems are preferred.

7.31 Extract grilles should be sited and balanced to promote air movement in the desired direction.

7.0 (a) Operating department ventilation systems

7.32 The information given in this section relates to General Operating Suites. It will be applicable to other types of theatre suite such as Maternity, Burns, Cardiac, etc. The standard values given may need to be adjusted to reflect non-standard room sizes, pressure regimes and air change rates.

7.33 A method of obtaining a design solution for non-standard theatres is given in Appendix 4.

7.34 Additional information for UCV theatres is given in Section 7.0 (b).

General

7.35 The supply of air to an operating room has four main functions:

- to dilute airborne contamination;
- to control air movement within the suite such that the transfer of airborne contaminants from less clean to cleaner areas is minimized;
- to control the temperature and if necessary the humidity of the space;
- to assist the removal of and dilute waste anaesthetic gases.

7.36 Because of the complexities of controlling air movement patterns, much design effort will be required for this aspect. It is important that the design makes the best possible use of the air available, as excessive supply air flows for the control of air movement should not be used. The amount of air supplied to the operating room will be determined by the number of doors and desired air change rate.

7.37 The detailed considerations upon which the supply air flow rate is based are as follows.

Dilution of airborne bacterial contaminants

7.38 There are four routes that airborne contaminants may appear in an operating room:

- through the supply air;
- shed by operating staff;
- produced by the surgical activities;
- transferred from adjacent spaces.

7.39 Supply flow rates for the main rooms of the operating suite are given in Appendix 3. For the other areas where room sizes and activities vary from site to site, air change rates are given in Appendix 1; Table A1. These figures have been found to give sufficient dilution of airborne bacterial contaminants, provided the mixing of room air is reasonably uniform.

7.40 A downward displacement air distribution is preferred, it may be either turbulent or laminar flow. For turbulent flow the supply air diffusers should be positioned either in the centre of each quadrant of the ceiling or along a line between the centres of each quadrant. This should ensure that all parts of the room are actively ventilated and that there will be adequate air movement at the operating table. Laminar flow would be provided by a perforated plenum terminal centred above the operating table. (See Section 5 for additional guidance on supply terminals).

7.41 Suspended articulated equipment is usually fitted in theatres. These require significant structural steelwork in the ceiling void to cater for the loads imposed by the resulting bending moments. It is important to ensure that the void is deep enough to accommodate both the steelwork and the ventilation ducts. The location of the steelwork must not prevent a suitable layout of the ventilation ductwork and correct positioning of the supply air terminals. It needs to be recognised that the correct ventilation of an operating theatre plays a significant part in controlling healthcare acquired infections and is not subordinate to the desire to make equipment easy to move.

7.42 Horizontal flow distribution with or without a coanda effect can be difficult to set up correctly and are unlikely to be as effective in Theatre applications. It should not be used in new installations however space constraints may force its retention or replacement when refurbishing existing installations. Where fitted the supply grilles will require a means of directional adjustment.

7.43 For general operating theatres, the air supply would be filtered in the AHU. Terminal HEPA filters are not generally required.

Air movement control

7.44 The design of the system should seek to minimise the movement of contaminated air from less clean to cleaner areas. Transfer grilles enable air to pass in either direction between rooms of equal class and pressure. In older designs suitably dimensioned door undercuts were often used in lieu of transfer grilles. Pressure stabilisers operate in one direction only, they allow excess air to be directed to the area desired and assist in maintaining room pressure differentials.

7.45 The relative locations of supply and extract terminals and their design air volume rates will determine the basic air flow between adjacent spaces. Transfer grilles and pressure stabilisers will permit and control the flow of air between spaces ensuring a flow from the clean to less clean areas of the suite. Failure to provide such devices will lead to uncontrolled air flows when personnel move between rooms and doors being held partially open by air pressure.

Temperature and humidity control

7.46 Supply flow rates to achieve the required room conditions, are calculated conventionally, taking account of all heat and moisture gains and losses, and of maximum permissible temperature differences between the room and supply

air. In most applications the room being considered will be within the heated building envelope.

7.47 Temperature differences of up to 10 K for winter heating and 7 K for summer cooling must not be exceeded.

7.48 It is acceptable for the humidity to swing uncontrolled between 35% and 60% saturation.

Removal and dilution of waste anaesthetic gases

7.49 Anaesthetic gases are subject to occupational exposure limits. The air movement scheme should ensure that staff are in a clean air flow path. (See Section 7 paragraph 7.21).

7.50 Air extracted from operating suites should not be re-circulated, as it may contain malodorous contaminants, however an energy recovery system should be fitted in the extract in order to reduce the plant energy consumption. (See Section 4 paragraphs 4.142 - 4.147).

Fire aspects

7.51 When considering the overall air-flow movement, careful thought needs to be given to the operation of the ventilation system, to limit smoke spread in the event of a fire. However, this is a highly staffed department with a low fire risk/load status and these factors need to be recognised when developing the fire strategy. It is considered satisfactory to treat the complete operating department as a single fire compartment providing there are at least two exits from it. Over compartmentalisation can lead to difficulties in establishing clean air flow paths and room air dilution rates. This will lead to an increased risk of hospital acquired infections. Staff areas within the department should be treated as a sub-compartment. (See Section 6 paragraph 6.18).

Door protection

7.52 Air should flow from the cleaner to the less clean areas as shown in Appendix 2 Table A2. The factors that affect the likelihood of a reverse air flow through doorways are discussed in Section 7 paragraphs 7.24 - 7.26.

7.53 It is not possible to design an air movement scheme, within the restraints of the amount of air available, that will protect the operating room when two doors are simultaneously opened. The design process that has been used considers that each door is opened in turn and ensures that the direction and rate of airflow through any open doorway is sufficient to prevent any serious back-flow of air to a cleaner area.

7.54 Provided that the air change rates in Appendix A1 Table 1A are met, dilution will be sufficient to ensure that the occasional small back-flows created (when two doors are opened simultaneously; or when there is a high temperature difference across an open door) will have little effect on the overall air cleanliness of the affected room.

7.55 The following general points should be taken into consideration during the design of operating suites;

- number of exits – the fewer the number of rooms (and therefore doorways) leading from the operating room the better, as traffic is reduced and less complicated air movement control schemes are required;
- scrub and hand-wash facilities – these may be a part of the operating room, often in a bay. The bay would count as part of the operating room volume and should have a low-level active or passive extract to remove the moisture-laden air. Should a separate room be required for the scrub area, a door between the scrub-up room and the operating room is an inconvenience to scrubbed staff, and could be replaced by an opening. This opening should be larger than a normal single doorway;
- preparation 'Sterile Pack Store' (SPS) – if it is intended to 'lay up' instruments in the operating room, the preparation room is then used simply as a sterile pack store. The nominal room pressure can therefore be the same as that of the operating room and the air flow between the two rooms in either direction. Air supplied to the preparation room may be directed into the operating room either through a door mounted transfer grille or if no door is fitted, through the opening. Alternatively, stock ready-use sterile items can be located in a bay within the theatre. In this case, a portion of the total theatre supply air should be provided in the bay to ensure it is actively ventilated;
- preparation room 'Lay up' – when the preparation room is used as an instrument 'lay up' room, it should be regarded as being of greater cleanliness than the operating room, and the design should minimise the transfer of air from the operating room to the preparation room. Air supplied to the room may be directed to the operating room through a pressure stabiliser taking care not to compromise the air flow pattern in the operating room. The air may also be directed into a corridor;
- service corridor – if materials to be disposed of are placed in impervious material for transportation, it is not necessary to have a separate corridor for this purpose. However a service corridor has many operational advantages it terms of the flow of materials through the theatre suite. It also permits routine service and maintenance access without compromising the use of adjacent theatre suites.

Standard air movement control schemes

7.56 In the previous versions of this guidance standard air movement control schemes were given that provided a range of design solutions to typical operating suite layouts. These were satisfactory design solutions for 'standard' sized rooms within the suite but were never intended to be universal for any sized room or suite. Guidance on operating suites contained in HBN 26 (2004) has increased the recommended size of operating room from approximately 35m^2 to 55m^2. Associated room sizes and air change rates have also increased. This means that the original standard solutions are no longer appropriate for new build installations.

7.57 Because of the resulting increase in the volume of air supplied to the theatre, provision needs to be made to either actively remove it or allow it to escape passively through pressure stabilisers. The increase in room size has also made to number and position of air supply terminals critical to the effective ventilation of the room.

7.58 Four new standard solutions have been developed to reflect the current guidance on theatre suite layout and room sizes given in HBN 26 (2004) as well as the general increase in air change rates.

7.59 The most commonly used original standard solutions have been revised and updated. They have been retained in this guidance as they will remain applicable to older theatre suites that are being refurbished to their original performance standard. They will also be applicable in existing departments where space constrains do not permit the upgrading of suites to the latest standard of performance or where a pre built "shell" is being fitted out.

7.60 It is important to recognise that in any situation where a "non standard" room size or theatre suite layout is being considered, the designer must return to first principles when developing a solution. Examples of non standard configurations would be:

- cardiac theatres that typically have an operating room half as big again as normal, a perfusion laboratory and no anaesthetic room;
- operating departments served by a central instrument lay up preparation area rather than individual prep rooms;
- balanced flow theatres for infectious cases.

Appendix 4 contains a methodology for assisting the designer to arrive at a suitable solution.

7.61 The new and revised standard design solutions are as follows:

No 1 – Typical Conventional theatre – room sizes as HBN 26;

No 2 – Typical UCV theatre – room sizes as HBN 26;

No 3 – HBN 26 illustrated Conventional theatre;

No 4 – HBN 26 illustrated theatre with UCV terminal fitted;

No 5 – Pre 2006 Conventional theatre, single corridor (SHTM 2025; 1b);

No 6 – Pre 2006 UCV theatre, single corridor (SHTM 2025; 1a);

No 7 – Pre 2006 Conventional theatre, two corridor (SHTM 2025; 5b);

No 8 – Pre 2006 UCV theatre, two corridor (SHTM 2025; 5a).

7.62 Details of these standard solutions are given in Appendix 3. They contain diagrams that show the relationship of rooms and the various doors and transfer

devices between them, but should not be regarded as architectural layouts. The schemes have been developed using the calculation procedure described in Appendix 4. Important features of the solutions are:

- zone trimmer heaters – a trimmer heater battery is advocated when calculations indicate that the temperature differential between rooms may be greater than 2 K. Generally this will only be the case in the preparation room when designated as a lay up;
- the preparation room (sterile pack store)/operating room interface – these rooms are deemed to be of equal cleanliness, and thus a transfer grille is required between these rooms or the door can be replaced with an opening wider than a standard door;
- preparation (lay-up)/disposal room interface – pressure relief dampers are recommended here to provide an air path when doors are closed, while preventing back-flow when a door is opened elsewhere;
- operating room/anaesthetic room interface – pressure stabilisers, or in some cases, carefully sized transfer grilles are recommended here, and between the anaesthetic room and corridor, and between the operating room and corridor;
- operating room/scrub room interface – an opening is provided between these rooms. The flow of air through the opening provides protection, and gives bacterial dilution within the scrub room; the air is then exhausted to the corridor via a pressure stabiliser.

7.63 No mechanical supply or extract ventilation is provided in the scrub room, and thus when a door is opened elsewhere in the suite, the stabiliser will close, allowing the air to be re-directed to help protect the doorway. If the scrub is a bay within the theatre then a suitably positioned pressure stabiliser and / or active extract should be provided to ensure air movement and prevent a local build up of moisture.

7.64 Any other scheme may be used and the standard solutions applied, if the following conditions are met:

- room relationships in air network terms are as shown in the plans;
- door gaps approximate to those given in Component Data Base, see Appendix 2 Table A3 and the comment below;
- casual heat gains are accounted for;
- a trimmer battery is installed in the air supply system to the preparation room;
- leakage through the structure is kept to a minimum.

Note: It should be noted that many doors are now fitted with cold smoke seals as standard. These will significantly reduce the door leakage rate when new and undamaged. It is therefore recommended that provision for the design door leakage be factored into the sizing of the appropriate transfer grille or pressure stabiliser. Failure to do this will result in air gap whistles and doors being held partially open by air pressure.

7.65 It is recommended that every effort should be made to adopt one of the schemes described above.

Air terminals and air distribution within rooms

7.66 The selection and sighting of air diffusers will be critical in establishing an efficient pattern of mixing. To this end the diffusers selected must be fit for purpose. Ceiling mounted circular 'air master' style, square 'four way blow' or similar diffuser designs that provide a downward displacement, turbulent air flow are the preferred option. (See Section 5 paragraph 5.68).

7.67 Plenum style 'laminar' flow diffusers with a footprint that encompasses the operating site are acceptable but may be prone to buoyancy effects as a result of temperature difference. Manufacturers type test data should be consulted to ensure that the terminal will achieve the required performance envelope. Note that these are not true laminar flow systems in the strict sense of the word but produce a downward displacement parallel flow style of air distribution.

7.68 The diffuser equipment chosen should not cause 'dumping' and provide a velocity 1 meter above floor level at the operating position of between 0.2 m/s and 0.3 m/s.

7.69 In the operating room, the supply air terminals must be at high level, and should all be adjustable for rate of flow as well as being easily cleaned and silent in operation.

7.70 In order to ensure that all parts of the operating room are actively ventilated, there should be an air out path on each face or in each corner of the theatre. This may be provided by a pressure stabiliser, transfer grille, active or passive extract terminal. A minimum of three and preferably four air out paths, approximately equally spaced should be provided.

Automatic control

7.71 The automatic control of ventilation in operating suites needs to be simple and robust. Over reliance on complex room pressure and flow relationships linked to automatic fan speed control are unnecessary and in the long term have been shown to be unreliable. Complex software algorithms that can only be accessed and interpreted by off site specialists should not be used. Whichever control strategy is chosen it is important that on site staff have the facility to override the control system and keep the ventilation operating at least until the surgical procedure is complete. (See also Section 6; paragraph 6.11)

7.72 Theatre air-conditioning control sensors should be actively ventilated. They would typically be located in a sampling extract duct mounted in the surgeons panel, positioned at normal working height (1.8m above finished floor level) and be accessible for cleaning and the removal of fluff and lint.

7.73 Wall-mounted passive temperature and humidity sensors are not recommended.

7.74 Controls should be provided to enable operating department ventilation plants to be closed down when the operating suites are unoccupied. (See also Section 6 paragraph 6.24).

7.75 When in the 'off' mode, the control system should ensure that the ventilation plant is automatically reinstated if the space temperature falls below 15°C.

7.76 The theatre control panel should include plant status indication; clearly readable temperature and humidity indicating gauges; and means of adjusting the set point for temperature. Theatre ventilation plant status indication should be located at the staff control base.

7.77 Where it is considered necessary to fit a humidifier, it should be selected to humidify to 40% saturation at 20°C during the design winter outside conditions. The cooling coil should be able to remove sufficient moisture so that 60% saturation at 20°C is not exceeded during the design summer outside conditions.

7.78 Each operating suite should be served by an independent supply and extract plant.

Ventilation of operating department ancillary areas

General

7.79 There are advantages in providing mechanical ventilation to all areas of the department. Maintaining operating suite air flow patterns is simpler and grilles and diffusers can be sited to eliminate condensation on windows. Where radiators or embedded wall or ceiling panels are installed they should be confined to the corridors and staff only areas of the department.

Ventilation requirements

7.80 Appendix 2 Table A2 gives guidance on the operating department areas in descending order of cleanliness, and this should be considered in the overall design of the department ventilation systems. The specified flow rates of air through doors given in Appendix 2 Table A4 for the operating suite are not necessary for other areas of the department, however, the airflow directions must be maintained from the clean to the less clean areas.

7.81 All windows in the department should be double-glazed and hermetically sealed in order to ensure that the desired air-flow pattern is maintained under all external environmental conditions and to avoid infestation. Trickle vents if fitted will need to be sealed.

Systems design

7.82 The design of the ventilation system for the ancillary rooms depends on the overall configuration of the department. The plant for the ancillary rooms may need to be interlocked to the theatre suite plants so that reverse airflow patterns do not occur.

7.83 Extract grilles should be sited and balanced to promote air movement along the clean and access corridors towards the reception/transfer areas. This should not affect the air distribution in the operating suite(s).

Reception

7.84 The aim in these areas is to provide comfortable conditions having regard to the movement control requirements of the department as a whole. The number of air changes will depend of the particular design.

Central sterile pack store

7.85 The store needs to be maintained at a positive pressure in order to preserve the cleanliness of the outside of the packs; 6 air changes are recommended.

Recovery

7.86 The air change rate in the recovery room will be rather higher than that needed merely to provide clean, comfortable conditions, as it is necessary to control the level of anaesthetic gas pollution; 15 air changes are recommended, with a balanced air flow.

7.87 The supply air terminals should be ceiling mounted above the foot end of the recovery bed positions. Extract should be at low (bed height or below) level behind the bed head positions or in the corners. This will establish a clean airflow path so that staff do not inhale anaesthetic gases exhaled by recovering patients.

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7.0 (b) Ultra-clean ventilation systems

General requirements

7.88 The design philosophy of a conventionally ventilated operating suite is based on the need to dilute contaminants and control both the condition and movement of air in an operating suite. Ultra-clean ventilation (UCV) is a means of significantly increasing the dilution effect by providing a large volume of clean filtered air to the zone in which an operation is performed and sterile items are exposed. Air is discharged above the operating zone and while not truly laminar, its downward displacement purges the clean zone of contaminants and particles generated by the activities within it. The air flow in and around the clean zone also serves to prevent particles originating outside the zone from entering it. The resulting reduction in contaminants has been shown to significantly reduce post operative sepsis following certain orthopaedic procedures.

7.89 The number of bacteria that are present in the air at the wound site and exposed surgical items is dependent on the operating team, their procedural discipline, choice of clothing and the type of UCV system. Ultra Clean air is defined as that containing not more than 10 cfu/m^3.

7.90 UCV systems are very successful in reducing contaminants at the wound site so it is often considered that there is no need for complex air movement control schemes in the rest of the suite. However when designing the ventilation scheme it should be noted that the users may switch the UCV terminal to "set back" when non orthopaedic surgery is taking place. This is because the high air flow rates can cause increased moisture evaporation of exposed tissue which may be detrimental to the surgical outcome. In recognition of this, the ventilation scheme should be capable of providing operating conditions to at least a "conventional" theatre standard throughout the suite with the UCV in set back mode. It should also be remembered that suitable levels of ventilation will always be required in the peripheral rooms.

7.91 UCV systems can be designed and built from first principles or a range of bespoke modular units of varying shapes and sizes are available with each manufacturer having a slightly different approach to UCV design. Some systems are fitted with partial or full walls to delineate the clean zone and direct a laminar or exponential downflow of air within it. Other designs utilise slotted linear supply terminals to produce an air curtain around the clean zone together with laminar flow diffusers to provide a downward displacement supply within it. **Notwithstanding any variation in the design philosophy, all UCV systems will be required to achieve completely the performance standard set out in the "Validation" section of this document**.

7.92 As with conventional theatres, each UCV operating suite should have its own dedicated air handling unit (AHU) to the standard set out in Section 4 of this document. To ensure operational flexibility and permit routine maintenance, air handling units should not be shared between suites.

7.93 In retro fit installations, site conditions may preclude individual AHU's for each suite. In these circumstances an AHU may be shared between not more than two operating suites providing each suite has its own control of temperature. An accessible air flow measurement test point should be provided in the supply branch duct to each theatre so that the primary air volume to each UCV canopy can be determined. In addition the branch supply and extract should be capable of being physically isolated and the main air flow rate reduced so that either suite can be taken out of use without detriment to operating conditions in the other.

7.94 An inherent feature of a UCV system is its large air flow so it is essential to re-circulate the air supplied to the operating theatre and/or to recover its energy in order to optimise operating costs.

7.95 The primary fresh air volume supplied to an UCV suite will be the same as in a conventional suite and it should be dispersed to the rooms in the suite in the same manner. This is an important aspect of the design and requests by UCV suppliers for increased primary air supply volumes should be resisted.

7.96 Laying up in the clean zone is preferable bacteriologically. Where a Sterile Pack Store (SPS) Preparation room is provided a transfer grille will be required in the prep / theatre door.

7.97 If the Preparation room is intended to be used for 'laying up instruments', a pressure stabiliser will be required between the prep room and theatre. It should be fitted with a baffle to prevent air transfer interfering with the ultra clean airflow distribution. In addition the air supply to the lay up prep should be HEPA filtered to the same standard as that supplied to the operating theatre.

7.98 Separate scrub-up or disposal facilities are not necessary for air cleanliness although operational policy may prefer such a provision. A separate anaesthetic room should however be provided.

7.99 There is no aerobiological reason why two or more UCV systems should not be installed in a common area as long as adequate spacing is provided. These are known as Barn theatres and require special design considerations and operational discipline. The relative positions of the UCV units, temperature control range and location of doors and openings to other areas will all significantly effect the air flow at the operating positions.

Types of UCV system

Remote plant systems

7.100 In a remote plant system, all the air-conditioning equipment is located outside of the operating room, except for the uni-directional air flow terminal, terminal filter, air diffuser and the return air grilles.

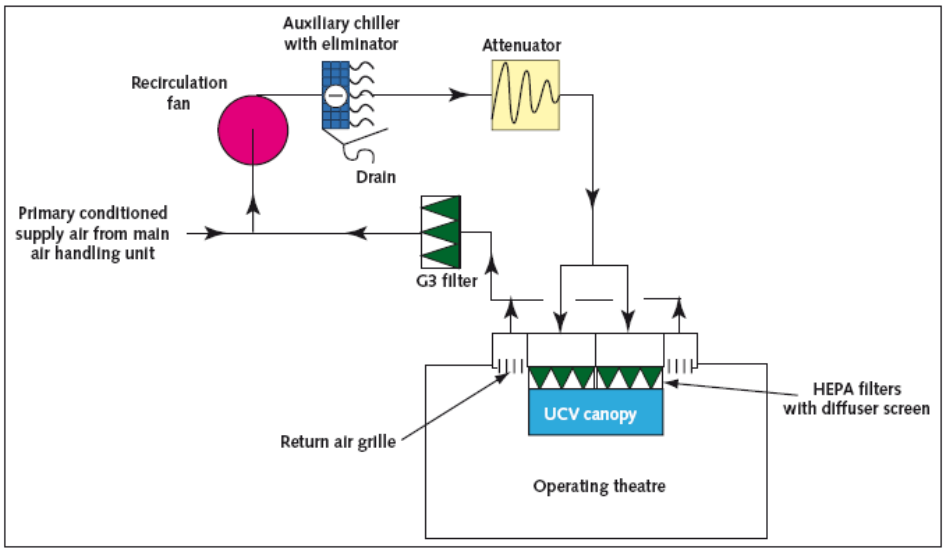


Figure 4 - UCV theatre with remote air recirculation

7.101 This arrangement is the preferred option for new installations as it has the following advantages:

- the recirculation fans are out of the theatre thus reducing noise. Multiple recirculation fans can be replaced by a single fan unit with its drive out of the air stream;
- casual heat gains from recirculation fan(s), canopy lights, equipment and people within the theatre can be removed by a chiller battery in the return air stream. This will prevent heat build up in the theatre;
- the return air filters can be changed without needing access to the theatre making routine maintenance more feasible;
- the opportunity exists to locate the HEPA filter in the primary supply duct rather than the theatre terminal. This will reduce the number of filters required and allow them to be changed without entering the theatre.

Modular systems

7.102 Modular systems are frequently used in retro fit applications. Vertical or horizontal units are available.

7.103 Vertical flow modular units comprise a ceiling mounted air terminal module containing return air filters, return air fans, final filter and air diffuser. Primary air is supplied by a remote air-conditioning unit at the volume and to the standard required for a conventional operating suite.

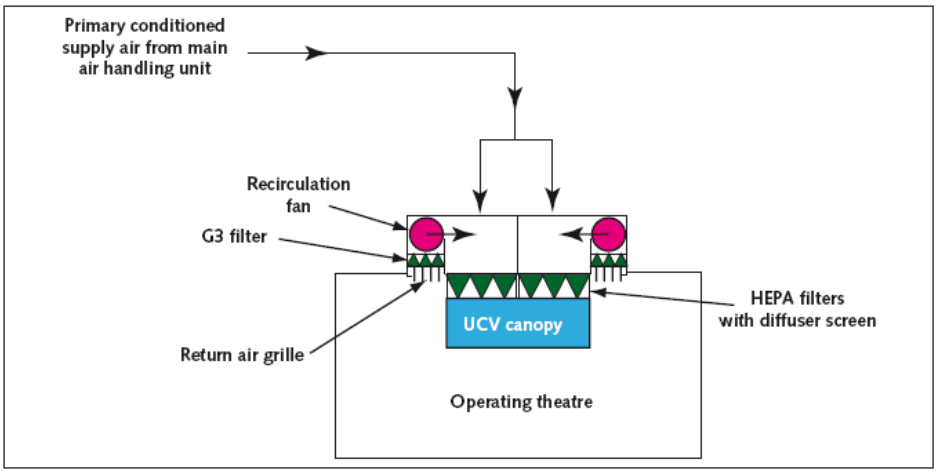


Figure 5 - UCV theatre with modular system

7.104 Horizontal or cross flow modular units comprise a wall mounted air terminal module standing vertically to produce a horizontal flow of air and containing final filter/diffuser, return air filters and fans. The module may incorporate a cooling unit or be supplied with 'fresh air' from a separate primary cooling system.

Vertical Flow UCV Systems

7.105 Vertical flow systems have a superior performance and are more effective at reducing infection risks. Air curtain or partial wall systems are acceptable, but are known to be more susceptible to problems arising from performance deterioration, poor operating team discipline and high occupancy rates than is the case with full wall systems. A full wall is considered to be any wall terminating not more than one metre above the finished floor level.

7.106 Because of the large volume of air being moved in a relatively small space, the siting of the return air grilles can cause short-circuiting of the air discharged through the UCV terminal. If the return air grilles are positioned at high level, partial walls should be provided to control short-circuiting. The partial walls shall be not less than 1m from the operating room walls and terminate at least 2m above floor level. The clearance should be increased proportionally for larger terminals (that is, 1.15m for 3.2m x 3.2m units and 1.25m for 3.5m x 3.5m units). In all cases, the side walls should terminate at 2m above floor level.

7.107 Siting the return air grilles around the periphery of the theatre at low level will eliminate short circuiting, remove the need for partial walls and give an improved air flow path. In any event there should be an 'air out' path on each face or in each corner of the theatre. These may be provided by combination of pressure stabilisers and passive or active low level extract grilles. Failure to provide 'air out' paths on all faces of the theatre may result in the surplus air causing entrainment into the clean zone.

7.108 Vertical systems should have a clean zone large enough to encompass the operating site and all of the instrument trays likely to be needed for the surgical procedures to be undertaken. Ophthalmic and minor hand surgery would typically require a 1·4m circular or rectangular terminal. For major orthopaedic procedures a minimum size of 2·8m x 2·8m will be required. This is the area projected on the floor under the supply air terminal within the partial walls, full walls or air curtain. Any air outside this zone cannot be guaranteed to be ultra-clean although given the dilution factor the level of microbiological contamination will be much lower than the general level in a conventional operating room. The use of lines or a coloured area on the floor delineating the extent of the clean zone will assist staff and is therefore essential.

7.109 When upgrading an existing conventional theatre to an ultra clean standard the only solution may be the installation of a modular system. In these units, the heat gains from the return air fans and terminal lights may warrant the inclusion of supplementary cooling within the module although modern luminaries contribute substantially less unwanted heat. However issues of cooling coil drainage, condensate removal and maintenance access within the space constrains of the module may make this option impracticable. The additional cooling load should then be catered for by conditioning the primary air to compensate.

7.110 If an existing AHU is to be retained, it may require modification to ensure that it achieves the minimum standards set out in Section 4 of this document. The fan may need re-rating to accommodate the change in system resistance. The

cooling coil may also need to be upgraded to cater for the increased load resulting from the return air fans and terminal lights. Failure to make adequate provision for this may make the theatre unusable during prolonged warm spells.

7.111 A factor affecting the air flow pattern is the supply or room air temperature difference. When the supply air temperature is significantly above room temperature, buoyancy effects will reduce the volume of air reaching the operating zone. If it is anticipated at design stage that this will be a regular occurrence, then a system incorporating full walls should be used. Demountable extensions that convert a partial wall to a full wall unit are available.

7.112 Convection up-currents from the surgical team and operating lamp tend to counter the movement of clean air towards the operating site, hence the air velocity reaching the operating level is critical. The minimum velocity given below has been selected to take account of these factors and is greater than the theoretical minimum value.

7.113 For all vertical UCV systems the design discharge velocities will be as follows:

Air velocity 2 metres above floor level:

- partial wall system = 0.38 m/s average;
- full wall system = 0.30 m/s average.

Air velocity 1 metre above floor level:

- all systems = 0·2m/s minimum within the operating zone.

The validation Section 8 paragraphs 8.75 – 8.86 gives details of the method of measurement.

7.114 Variable speed recirculation fans with differential pressure control may be the most suitable solution for maintaining consistent performance and energy saving.

Horizontal UCV systems

7.115 Horizontal UCV air flow systems have been shown to be less effective than vertical systems and are not the preferred solution. There may be occasions, however, where architectural, engineering, economic or workload considerations prevent the installation of a vertical flow system and only a horizontal flow system can be installed.

7.116 Horizontal or cross flow modular units comprise a wall mounted air terminal standing vertically to produce a horizontal flow of air across the operating field. The terminal module contains the final filters, air diffuser, return air grilles, filters and fans. The module may incorporate a full air-conditioning unit or be supplied with 'fresh air' from a separate primary air-conditioning system. In the later case the return air fan power may warrant the inclusion of a supplementary cooling coil within the module.

7.117 The system shall have side wall panels at least 2·4m apart, the panels may fold to facilitate cleaning of the theatre. The minimum height of the terminal should be 2·1m and a deflector at the top of the filter/diffuser will be acceptable as an alternative to a full roof. These dimensions reflect currently available equipment and may impose operational constraints in addition to a lower level of performance common to these systems.

7.118 In the horizontal flow systems, personnel working between the filter and surgical wound will disperse bacteria that are more likely to contaminate exposed surgical instruments and enter the wound. This may be minimised by the use of improved clothing and operating procedure to reduce dispersion of bacteria. The use of lines on the floor delineating the extent of the clean zone and hatching or colour coding the 'no-entry' zone between the air diffuser and patient will serve to prompt staff and are therefore essential.

7.119 The air discharge velocity as measured 1m from the diffuser face shall have a mean value of 0·4 m/s. The validation section 8 gives details of the method of measurement.

Filters

7.120 The main plant primary and secondary filters should be to the standards and in the location set out in Section 4.

7.121 Terminal filters shall be provided within the air flow terminal or in the air supply to it. High efficiency particulate air (HEPA) filters grade H12 as specified in BS EN 1822 will be required as a minimum. There is no aerobiological benefit in fitting filters of a higher grade than this.

7.122 In some modular UCV units, the terminal filter is used as a pressure equaliser to balance air-flow and filters of a higher grade with a greater pressure drop may be recommended by their manufacturer. The increased resistance may affect the velocity of air reaching the operating level and there will be penalties in terms of installed fan power and higher noise levels.

7.123 The final filters shall be installed in a leak-proof housing in a manner which allows the terminal unit, filters and their seals to be validated. A challenge test will be carried out during commissioning to prove the effectiveness of the complete installation.

7.124 Where UCV units are constructed in sections, a means of measuring the pressure drop across the terminal filters in each section shall be provided. The pressure test points should be located outside of the partial wall, capped to prevent air leakage and accessible within the theatre without the need to open the unit inspection panels. Alternatively direct reading pressure gauges should be fitted.

7.125 The UCV system will require a return air filter to capture the relatively coarse particles which would otherwise significantly reduce the life of the final filter. This should be at least a G3 grade to BS EN 779. In remote recirculation

systems there may be advantages in fitting a higher grade return air filter as it will reduce the load on the terminal HEPA filters and extend their life.

Noise level

7.126 If sound attenuating material is used to line any portion of the inside of the UCV unit it should be non particle shedding and fire resistant. (Further guidance can be found in SHTM Firecode suite of documents).

7.127 The maximum noise level in an operating room fitted with a UCV terminal of any type shall not exceed 50 NR. The validation section gives details of the method of measurement.

Lighting and Operating Lights

7.128 CIBSE lighting guide LG2 and BS EN 12464-1 give detailed information of lighting requirements. Operating luminaires should comply with the photometric requirements detailed in relevant sections of BS EN 60601.

7.129 The position of the UCV light fittings and style of partial walls, where fitted, should neither adversely disturb the air flow nor result in significant spatial variations in illuminance levels.

7.130 In vertical units, specialised task lighting should be provided by toroidal, cruciform or small multiple dome-shaped luminaires as they have good aerodynamic properties. The ideal luminaire will have a minimal effect on the air flow regardless of where it is positioned. Large diameter saucer-shaped luminaires should not be used in vertical flow systems as they will occlude the air flow in the critical central zone. It is important to consider the suitability of existing luminaires when retro fitting UCV systems.

7.131 In vertical UCV installations a minimum of 2·75m from floor to underside of the diffuser is required to allow for supporting mechanisms and lamp articulation. When upgrading existing systems this dimension may not be achievable however, when parked, the lowest point of the central light stem, luminaire and articulation arms should never be less than 2m above floor level.

7.132 The traditional means of light support is a central column that passes through the UCV terminal and is rigidly fixed to the building structure. The position of the support therefore prevents air being supplied at the centre of the terminal. Separate supports displaced from the centre of the clean zone would lead to improved air flow. This approach was advocated in the 1994 version of this guidance but at the time of writing no UK manufacturer has chosen to adopt this solution.

7.133 In horizontal units the size or shape of the specialised task luminaire has little effect on the air flow pattern.

Controls and instrumentation

7.134 The functions of the supply AHU and extract ventilation should be continuously monitored by a BEMS control unit. The controls and instrumentation for the main plant are set out in Section 6.

7.135 UCV systems will additionally require:

- a set-back facility that can reduce the air supplied through the UCV terminal to a volume that equates to not less than 25 air changes per hour of the operating room gross volume whilst still leaving the supply AHU operating at full speed;
- a facility to turn the entire system, supply AHU and UCV terminal, off. (N.B. An emergency stop is not required);
- a readout sufficiently large to be clearly visible from the operating table that shows the temperature of the air being supplied by the UCV terminal;
- a readout sufficiently large to be clearly visible from the operating table that shows the relative humidity of the air being supplied by the UCV terminal;
- a red indicator light that will illuminate when either the supply AHU or the UCV terminal fails, or either or both are switched off or at set-back;
- an amber indicator light that will illuminate when the UCV terminal is at set back and the supply AHU is running;
- a green indicator light that will illuminate when both the supply AHU and UCV terminal are operating at full speed;
- a blue indicator light that will illuminate when the UCV terminal air flow, as detected by a differential pressure sensor, falls below 80% of the design flow rate.

7.136 The switching devices and indicators should be incorporated in the surgeons panel and their functions clearly labelled. In retro fit installations an auxiliary panel for the UCV may be the most practical option. If fitted it should be mounted adjacent to the surgeons panel and their control functions interlocked as necessary.

7.137 When a system is designed to have partial walls with full wall extensions, a volume control facility may be incorporated to allow the system to be run with reduced velocity when the demountable full-walls are in place. It would be the responsibility of the user to ensure correct operation of the system. To assist the user an explanatory notice should be included on the theatre control panel.

7.138 A direct reading gauge should be fitted in the theatre to show a representative pressure drop across the final filters. If the UCV control box is located out of the theatre and has a means of manually adjusting the return air fan speed then it should also be fitted with a direct reading differential pressure gauge. The means of adjusting the return air fan speed should be lockable to prevent casual adjustment. The direct reading gauges should be fitted with a means of indicating the correct operating pressure range.

7.139 The UCV unit manufacturers control box should be located in an accessible position preferably in the operating department adjacent to the operating theatre that it serves. A service corridor, if provided, is an ideal location. The control box should be clearly labelled with the identity of the operating theatre that it serves.

AHU	UVC terminal	Indicator light	Comment
Off or Fault	Off or Fault	Red	Ventilation not operating at a suitable level to commence surgical procedures
Off or Fault	On (set-back)		
Off or Fault	On (full speed)		
On (set-back)	Off or Fault		
On (full speed)	Off or Fault		
On (set-back)	On (set-back)		
On (full speed)	On (set-back)	Amber	Ventilation provided to at least conventional theatre standard
On (full speed)	On (full speed)	Green	Full UCV standard conditions
–	–	Blue	HEPA-filter resistance causing low air flow

Table 6 - Indicator light logic table

7.0 (c) Extract Systems

7.140 Extracts may be provided for a variety of reasons including:

- Simple odour control (for example in a WC or mortuary);
- To receive and remove moisture laden air (for example, in a kitchen);
- As part of a combined supply/extract balanced system (for example, in an operating suite);
- To capture a hazardous substance at source (for example a safety cabinet).

7.141 Devices that use an inflow of air to control exposure of staff to hazardous substances are classified as Local Exhaust Ventilation (LEV) systems under the COSHH Regulations.

7.142 An LEV system may comprise a self contained unit incorporating its own carbon filter such as a simple bench top fume cupboard. Alternatively it may be a complete "ventilation system" comprising a make up air supply, multiple exhaust protected work stations, branch and central extract ductwork, duplex extract fans and a high level discharge terminal. It may also incorporate a special filtration system appropriate to the hazardous substance being controlled. Such systems could be required for workshops containing wood working machinery or large centralised pathology laboratories housing multiple safety cabinets, dissection benches, fume cupboards and specimen stores.

7.143 It is important to recognise at the design stage whether an extract is being provided for comfort or as an LEV system. Typical systems in healthcare include:

- microbiological safety cabinets and Cat 3 containment rooms;
- fume cupboards;
- welding fume extracts;

- wood working machinery duct collectors;
- battery charging bay extracts;
- powered plaster and bone saws;
- pharmaceutical preparation cabinets and tablet machines;
- fissection benches, cut up tables and some specimen stores;
- medium and high risk infectious disease isolation facilities;
- dental furnaces, grinders and polishers.

7.144 General design information and guidance for LEV systems is produced by the Health and Safety Executive (HSE) as HS(G)37. Information on the design and installation of microbiological safety cabinets is given in BS5726 and that for fume cupboards is given in BS EN 14175. Their recommendations should be closely followed.

7.145 LEV systems are statutory items that will be subject to an independent inspection every 14 months.

Hood extract systems

Special requirements

7.146 Extract canopies will be required over steam-and-heat-emitting appliances, for example sterilisers, catering and washing equipment; and for the extraction of toxic fumes over benches used for mixing, sifting and blending procedures.

7.147 Perimeter drain gulleys and corrosion-proof grease eliminators should be provided on kitchen hoods.

Typical arrangements

7.148 The air-flow rate must be sufficient to ensure an adequate capture velocity in the vicinity of the process; typical values are as follows:

- evaporation of steam and like vapours 0.25 m/s to 0.5 m/s;
- chemical and solvent releases 1.0 m/s;
- vapour of gases 5 m/s to 6 m/s;
- light dusts 7 m/s to 10.0 m/s.

Excessive velocities will be wasteful of power and generate noise.

7.149 The lowest edge of the canopy should be 2m above finished floor level, with a minimum of 300mm overhang beyond the edge of the equipment on all sides.

7.150 A compact arrangement of equipment (but with access for maintenance) will minimise the canopy area, and hence reduce the air volume necessary to achieve the optimum capture velocity.

7.151 Hoods required for the control of heat gain and vapours may be connected to the general extract system when it is convenient to do so, but where non-corrosive ductwork materials are necessary, a separate discharge is preferred.

7.152 Lighting and internal divider plates are often required to be built into the perimeter of large canopies; however, built-in shelving systems are not recommended, as they interfere with the airflow, and constitute a maintenance problem.

Control of hood extracts

7.153 Provided that it does not interfere with the operation of the department when not in use, the ventilation system for the hood extract any associated supply can be shut down. To this end, local control should be provided.

Bench extract systems

Special requirements

7.154 Bench extract ventilation is required in departments such as pathology and mortuary, where activities involve the release of malodorous or toxic fumes which should not be inhaled.

Typical arrangements

7.155 Each ventilated position will usually be accommodated in a continuous run of benching, which should not be more than 650 mm from front to rear and which should be provided with a continuous upstand at the rear. Each position should have a 1200mm x 150mm linear extract grille mounted on a purpose-designed plenum box (incorporating guide vanes as necessary), with its face flush with the upstand. The bottom of the grille should be as close as practicable to the level of the working surface (usually 75mm above, to allow for cleaning). The minimum velocity across any part of the grille should be 1 m/s. The grille should be readily demountable to allow for cleaning.

Control of bench extract systems

7.156 Provided that it does not interfere with the operation of the department when not in use, the ventilation system for the bench extract and any associated supply can be shut down. However, a run-on timer with a minimum setting of 30 minutes must be provided. To this end, local control should be provided.

7.157 Processes that produce hazardous vapours, fumes, dusts or noxious vapours should be enclosed or semi enclosed in a suitable cabinet or exhaust protected work station.

Safety cabinet and fume cupboard extract systems

7.158 Safety cabinets and fume cupboards are devices that use an inflow of air to control exposure of staff to hazardous substances. The units, their exhaust systems, filters, fans and discharge terminals are all classified as Local Exhaust Ventilation (LEV) systems under the COSHH Regulations. The make up air

system to a room that contains an LEV system may also be considered as an essential part of the system and be included in the LEV classification.

7.159 The Advisory Committee on Dangerous Pathogens (ACDP) publishes 'The Management, Design and Operation of Microbiological Containment Laboratories' covering the general environment in which they are used and operational considerations.

Special requirements

7.160 The supply air system should not distort the uni-directional and stable air pattern required for fume cupboards and microbiological safety cabinets. In general, supply air ceiling diffusers should not discharge directly towards fume cupboards or safety cabinets, unless the terminal velocity is such that the air-flow pattern of the cabinet is unaffected. The design should ensure that high air change rates, and/or the opening and closing of doors do not have any adverse effect on the performance of safety cabinets or fume cupboards. A damped door closure mechanism may help.

7.161 In order to safeguard the user, all safety cabinets and fume cupboards must be fitted with a clear indication that they are operating correctly. Direct-reading gauges or falling-ball indicators are preferred (in addition to electronic pressure indicators). The system should be set to alarm audibly if the face velocity falls below the minimum safe operating level.

Arrangements for safety cabinet installations

7.162 The manufacture and installation of microbiological safety cabinets must be in accordance with the relevant national standards and guidance issued by the Advisory Committee on Dangerous Pathogens (ACDP).

7.163 A Class 1 microbiological safety cabinet must be specified for routine work involving Group 3 pathogens. It should be housed in a Category 3 containment room. Specific design information on containment rooms is issued by ACDP in conjunction with the Health and Safety Commission.

7.164 Siting and installation of microbiological safety cabinets are of particular importance because:

- the protection afforded to the operator by the cabinet depends on a specific and stable uni-directional air flow through the open front;
- the protection to the environment by the cabinet depends on the high efficiency particulate air (HEPA) filters. The exhaust air should never be considered as totally free from microbiological hazard.

7.165 Microbiological safety cabinet is HEPA filtered prior to being discharged to outside. The extract ductwork should as far as practicable be kept under negative pressure while inside the building.

7.166 Current standards permit the installation of microbiological safety cabinets with integral fans, provided that the extract ductwork can be kept short (that is, less

than 2m); such an installation however, is likely to be noisy and is not recommended for use in new buildings.

7.167 The discharge from the cabinet should be fitted with a back draft damper. In multiple installations where several cabinets discharge into a common extract and discharge duct, it must be possible to isolate each cabinet from the system when not in use.

7.168 Roof-level discharge, wherever practicable, is preferred since it removes much of the uncertainty over air re-entering the building through ventilation inlets and/or windows. In such an installation, the extract fan should be situated separate from the cabinet and close to the discharge outlet, to maintain the duct within the building under negative pressure. The discharge point on a flat roof should be through a 3 metre high terminal. This is required to safeguard staff who may need to access the roof periodically for maintenance. This requirement will also be applicable to fume-cupboard discharges.

7.169 Where this is impracticable, discharge into the room via a double HEPA filter has been accepted; the preferred method however is to discharge 3 meters above the roofline in line with the similar standard for fume cupboard designs.

Arrangements for fume cupboard installations

7.170 The manufacture and installation of fume cupboards must be in accordance with the relevant national standards and associated guidance.

7.171 The primary factors which contribute to the effective performance of fume cupboards include:

- an adequate volume of supply air;
- an effective exhaust system to promote the safe dispersal of waste products to atmosphere.

7.172 The air velocities through sash openings must be sufficient to prevent hazardous materials from entering the laboratory while avoiding excess flow rates that interfere with the investigation process. Average face velocities should be between 0.5 and 1.0 m/s, with a minimum at any point within 20% of the average, the upper end of the range being applicable to the containment of materials of high toxicity. The design velocity must be maintained irrespective of whether the sash opening is varied, or whether doors or windows are open or closed.

7.173 The possibility of a fire or explosion which may not be contained by a fume cupboard must always be considered. A fume cupboard should not, therefore, be sited in a position where exit to an escape route will necessitate passing directly in front of it.

7.174 Fume cupboard fans should be installed as near as possible to the termination of the duct, thus maintaining the maximum amount of ductwork at negative pressure.

7.175 Where there are adjacent buildings with opening windows, or where downdraughts occur, it may be necessary to increase the height of discharge ducts in order to achieve adequate dispersal. In complex locations, air-flow modelling or wind tunnel tests may be required to determine the optimum height of the stack.

7.176 Fume cupboards for certain processes must have separate extract systems; however, where appropriate, individual fume cupboard exhaust systems may discharge via non-returning dampers into a single collection duct rather than having a large number of separate stacks. The collection duct should have a large cross-sectional area to minimise its effect on the individual exhaust systems; be open to atmosphere upstream of the first connection; and be designed to discharge a total air volume at least equal to the combined individual extract systems.

7.177 Individual fume cupboard extract systems, discharging either directly to atmosphere or into a collection duct, do not require duplex fans. However, a collection duct designed to provide dispersal of effluent from a number of individual extracts, should have duplex fans with automatic change-over.

7.178 Some fumes are particularly corrosive, so the choice of material for the ductwork, and type of extract fan fitted should reflect the nature of the fume being conveyed.

Control of extract systems

7.179 It is desirable to provide local control of safety cabinets in order to maximise the life of the HEPA filter, and to permit the sealing of the cabinet and room for fumigation if spillage occurs.

7.180 To cope with the risk of an accident or spillage outside safety cabinets, a ‘panic button’ should be provided to switch off the supply to that area; and discharge all extracted air to atmosphere.

7.181 In pathology departments, it will be necessary to have one or more microbiological safety cabinets and one or more fume cupboards available for use at all times, including weekends, therefore, local overriding controls for all these items and any associated ventilation plant will be necessary.

7.0(d) Plantroom ventilation

General requirements

7.182 Plant rooms are required to be ventilated in order to maintain acceptable temperatures for satisfactory operation of the plant and controls, and for maintenance activities. In the case of plant rooms housing combustion equipment, a secondary function of the ventilation is to provide make up air for the combustion process.

7.183 The air required for these purposes should be introduced into the space through inlets positioned to minimise the discomfort to occupants; they should be unlikely to be blocked, closed deliberately (except in the case of fire shutters if required), or rendered inoperative by prevailing winds.

7.184 Plantroom ventilation air should not be used for any other purposes, such as make-up air for extract; and where the plantroom contains combustion equipment, the appliance pressure must not fall below the outside air pressure.

7.185 Specialised healthcare air handling equipment must not be located in a fire compartment that houses combustion equipment.

7.186 Statutory regulations for plantroom ventilation are contained in the Building Regulations, and further guidance in CIBSE Guides A & B.

Assessment of ventilation levels

7.187 Ventilation requirements must take into account all heat sources within a plantroom, and where there are large glazing areas, solar gains. The ventilation rate should limit the maximum temperature within the plantroom to 32^{o}C.

7.188 As the level of equipment operating during mid-season and summer is often lower than the winter condition, and the cooling effect of the outside air is reduced, it is necessary to calculate the minimum volume for each season of operation, and the inlet and outlet grilles or fan sizes should be chosen to cater for the largest seasonal air volume.

7.189 Replacement air should not be drawn through pipe trenches or fuel service ducts. Where metal ducts penetrate walls and floors, effective sealing should be provided to confine the ventilation to the boiler room and to meet fire protection requirements. Penetration of fire barrier walls by ventilation ducts should be avoided if possible.

7.190 Fire dampers in plant room ventilation ducts should be electrically interlocked with the boiler plant.

7.191 Care must be taken to prevent any noise generated in the boiler room emerging from natural or mechanical ventilation openings to the detriment of the surrounding environment. Particular care is necessary with mechanical flue draughts and fan-diluted flue systems.

7.192 Information on required air volumes in contained in the CIBSE Guide A & B.

7.193 Where combustion plant is installed, the high-level (outlet) openings should be sized to cater for the total ventilating air quantity; and the low-level (supply) openings sized to cater for the total combined ventilating and combustion air quantity.

Choice of ventilation system

7.194 The ventilation air may be introduced and exhausted by either natural or mechanical means or a combination of both; however, where possible, natural systems are preferred.

7.195 Generally, small installations at or above ground level should have their combustion and ventilation air provided by natural means, employing both high and low-level openings.

7.196 Basement, internal and large installations at or above ground level will usually require a combination of natural and mechanical ventilation. If the air-flow rate is difficult, both supply and extract may require mechanical means.

7.197 Whether natural or mechanical, the system should be designed to avoid both horizontal and vertical temperature gradients. Both inlet and outlet openings should be placed on opposite or adjacent sites of the building to reduce the effect of wind forces.

7.198 Where mechanical air supply is employed, electrical interlocks with the boiler plant should be provided to prevent damage in the event of failure of the supply fan(s) once the air volume is established.

7.199 The necessary free opening areas for a naturally ventilated plantroom may be calculated using either the method in A4 of the CIBSE Guide A or the table in section B13 of CIBSE Guide B.

7.200 A combined natural and mechanical ventilation system should allow for natural extract at high level, to take advantage of convective forces in the room, with mechanical supply at low level. The high level natural ventilators should be sized to cope with the total quantity of ventilation air, as above.

7.201 To prevent leakage of flue gases and to ensure that the flue draught is not impeded at any time, the air pressure in the boiler room must not exceed the prevailing outside pressure. Therefore, the fan duty should exceed the calculated total combined combustion and ventilation air quantity by at least 25%. Fan-powered inlets should be arranged to flow outside air into the space at a point where cross-ventilation will ensure pick-up of heat without causing discomfort to occupiers.

7.202 Where it is impractical to provide sufficient natural ventilation to remove the heat emitted by the plant, both mechanical supply and extract will be required.

7.203 The high-level extract should be sized to cater for the total ventilating air quantity and the low-level supply should exceed the total combined combustion and ventilating air quantity by at least 25%, as above.

7.0(e) Ventilation of hydrotherapy suites

General requirements

7.204 The Departmental Cost Allowance for a hydrotherapy suite includes for heat recovery via heat pump.

7.205 The quantity of supply air should be calculated as 25 litres/sec/m^2 wetted surface, with the wetted surface taken as 110% of the pool water surface area.

7.206 A re-circulation plant is recommended, with a minimum of 20% fresh air.

7.207 As far as practicable, re-circulated pool air should be provided to the ancillary changing and recover accommodation, with the only extract from the toilets, laundry/utility room and pool hall.

7.208 Supply air to the pool hall should be introduced at high level and directed towards the perimeter to mitigate condensation, with extract air taken from directly over the pool. Dampers should not be located over the pool water.

Control of hydrotherapy pool installations

7.209 The supply and extract fans should be interlocked so that the supply fan does not operate until flow is established within the extract system.

7.210 Time-clock control should be provided, with a local override switch to extend the normal operating period as required.

7.211 Night set-back temperature (in the range of 21-25^{o}C) and high humidity control (in the range of 60-75% sat) should be provided to override the time-clock in order to prevent condensation. The exact set points should be ascertained post-installation.

7.212 A remote indication panel should be provided in the pool hall, giving a visual display of the pool water and pool air temperature.

8.0 Validation of specialised ventilation systems

Definitions

Commissioning - Commissioning is the process of advancing a system from physical completion to an operating condition. It will normally be carried out by specialist commissioning contractors working in conjunction with equipment suppliers. Commissioning will normally be the responsibility of the main or mechanical contractor.

Validation - A process of proving that the system is fit for purpose and achieves the operating performance originally specified. It will normally be a condition of contract that "*The system will be acceptable to the client if at the time of validation it is considered fit for purpose and will only require routine maintenance in order to remain so for its projected life.*"

Commissioning is often sub divided into sections e.g. air handling unit, automatic controls, air side balance, building fabric and fittings. Each section may be commissioned by its specialist installer and they are often accepted in isolation. Validation differs from commissioning in that its purpose is to look at the complete installation from air intake to extract discharge and assess its fitness for purpose as a whole. This involves examining the fabric of the building being served by the system and inspecting the ventilation equipment fitted as well as measuring the actual ventilation performance.

It is unlikely that 'in house' staff will possess the knowledge or equipment necessary to validate critical ventilation systems such as those serving operating suites, pharmacy clean rooms and local exhaust ventilation systems. Validation of these systems should therefore be carried out by a suitably qualified independent Authorised Engineer appointed by the Health Board.

It is anticipated that training in the validation of specialised healthcare ventilation systems for independent Authorised Engineers will become available during the life of this SHTM.

Commissioning General

8.1 Commissioning is an essential process for ventilation systems. It is therefore important that adequate provision for the process be made at the design stage of the project. Procedures for commissioning air-handling systems are given in CIBSE Commissioning Codes and BSRIA Application Guide Set COMPAK 1.

8.2 The duct sizing procedure should take into account the requirements of system balancing, and the position and number of regulating dampers included in the design should be sufficient for this purpose.

Location of dampers and test holes

8.3 Balancing/commissioning dampers will be required in each branch of the distribution ductwork.

8.4 Test holes for the measurement of air-flow will be required at carefully selected points in main and all branch ducts. The number and spacing of holes are given in the BSRIA Application Guide Set COMPAK 1. Their positions must be identified at the design stage.

8.5 The test positions need to be accessible for commissioning to take place. They may also be required for subsequent annual verification of the system performance so they should not be covered by permanent lagging.

8.6 The measurement point should be in a straight length of duct as far away as possible from any upstream bends, dampers or other elements that could cause disturbance to the air flow. The actual location should be:

- at least 1.5 duct diameters upstream of sources of turbulence such as dampers and bends;
- if this is not possible, 10 diameters downstream of dampers, bends or tees, and 5 diameters downstream of eccentric reducers;
- where there is enough space round the duct to insert the pilot tube and take readings;
- where the duct has a constant cross-sectional area.

8.7 Test holes for measuring total air-flow from a fan should be located either 4 diameters upstream, or 10 diameters downstream of the fan. Provision should also be made for measuring the speed of rotation.

Information to be provided

8.8 It is essential that the designer should pass on his intentions fully to the commissioning engineer by indicating which parts of the system are high, medium and low pressure, and by providing:

- relevant parts of the specification;
- schematic drawings indicating data listed in Table 8.1;
- equipment schedules;
- controller and regulator schedule;
- fan performance curves;
- wiring diagrams for electrical equipment, including interlock details.

Items in system	Information to be provided
Fans	Fan total pressure Volume flow rate at high and low speed Maximum motor current
Plant items	Type and identification numbers from equipment schedules Fluid and air volume flow rates Fluid and air side pressure losses Dry bulb temperatures Wet bulb temperatures Humidity
Dampers, including motorised and fire dampers	Identification numbers from equipment schedules Location Identification number Volume flow rate
Main and branch ducts	Dimensions Volume flow rates and velocities Identification numbers from equipment schedules
Terminal	Location Identification number Grille or diffuser factor Volume flow rate and neck velocity Operating static pressure
Test holes and access panels	Location Identification number
Controllers	Set points

Table 7 - Information to be provided on schematic drawings

Notes:

1. Fan total pressure is the difference between the total pressure (static pressure + velocity pressure) at the fan outlet and the total pressure at the fan inlet.

2. Where volume flow rates are variable, maximum and minimum values should be provided.

Commissioning personnel

8.9 It is unlikely that all of the required commissioning skills will be possessed by one individual; a commissioning team is therefore usually needed. The objective of commissioning is to ensure that the necessary performance and safety requirements are met.

8.10 During the commissioning process a great deal of information will be generated which will form an invaluable future source of reference about the plant. It is essential to ensure that it is collected together in the form of a commissioning manual and handed over to the client on completion of the contract together

with the 'as fitted' drawings. This information should be both in hard copy and electrictronic format.

8.11 In order to be successful the commissioning process must start before practical completion as many parts of the system will become progressively less accessible. The correct installation of those parts will need to be witnessed and leak rate tests carried out as construction proceeds. Failure to establish responsibility for commissioning early enough will delay the completion of the project or lead to unsatisfactory plant performance.

Commissioning brief

8.12 The commissioning team will require a detailed brief from the system designer. This should include:

- a 'user' brief comprising a description of the installation and its intended mode of operation;
- the precise design requirements with regard to the scheme of air movement, room static pressures, supply and extract air flow rates and acceptable tolerances;
- full details of the design conditions both inside and out, for winter and summer together with the control strategy;
- equipment manufacturer's type test data, commissioning, operation and maintenance recommendations;
- drawings showing the layout of the system, positions of air flow measurement test points, dampers, regulating devices and filters within the duct runs, together with sizes of ducts and terminal fittings. It will save time if these drawings are annotated with the design volumes and static pressures required at each branch and outlet point;
- wiring diagrams for all electrical equipment associated with the air handling systems including motor control circuit details and any interlocking and safety devices such as emergency stop buttons adjacent to the item of plant.

8.13 The CIBSE Commissioning Code, Series 'A' – "Air Distribution", provides full guidance on the information that will be required by the commissioning team.

8.14 The designer should include in the contract document instructions on verifying the accuracy of test instruments which should be supported by reference to relevant calibration certificates.

8.15 The system, on completion should be operated by the contractor as a whole and subject to performance tests in accordance with the contract requirements. These may include independent validation of the system performance on behalf of the client.

8.16 Prior to dynamic commissioning, it is essential that builders' work in the area served by the system is complete, all rubbish and dust is removed, concealed

plumbing (IPS-type) panels are in position and ceiling tiles are in place and clipped. Floors should be mopped and visible dust removed from all other surfaces.

8.17 Once the system is shown to meet the design intent the handover documentation should be completed. In the event of performance not being acceptable, the matter should be dealt with in accordance with the contract arrangements.

Pre-commissioning checks

8.18 The pre-commissioning checks consist of visual inspection, manual operation of equipment, static measurements and functional tests of individual components. They should be carried out prior to setting the system to work and undertaking the dynamic commissioning process set out in paragraph 8.29 onwards of this guidance.

Standard of Installation

8.19 During the installation of the system the following must be witnessed:

- that the plant and installations have been provided and installed in accordance with the design specification and drawings;
- that only approved sealants have been used in the installation;
- that all components function correctly;
- that the satisfactory sealing of access doors and viewing ports have been carried out;
- that air pressure tests and air leakage tests on ventilation ducting have been carried out in accordance with the methods set out in the HVCA's DW/143: Ductwork Leakage Testing. It is usual to carry out these tests, a section at a time, as the ductwork is installed and before its insulation is applied. The results must be recorded in the commissioning manual;
- that gaps around doors and hatches are as specified in the design;
- that the correct operation of pressure stabilisers, control dampers, isolating and non-return dampers have been checked;
- that test holes have been provided in their specified locations and are sealed with suitable grommets;
- that control dampers are secured and their quadrants fitted correctly;
- that any interlocks are operative and in accordance with specification;
- that the electric circuits are completed, tested and energised;
- that electric motors have been checked for correct direction of rotation both at full speed and set back;
- that cooling and heating media are available at correct temperatures and pressures and in specified quantities;

- that the air-conditioning plant components and controls function correctly;
- that the air-conditioning plant interlocks and safety controls function correctly;
- that the plant is physically complete, insulation is applied and all ducts and pipework are identified as specified;
- that the building housing the ventilation plant is generally in a fit condition for commissioning and performance tests to commence, that is, windows, doors, partitions etc are completed, surfaces sealed and their final finish applied;
- that the areas containing the ventilation plant and those being served by it are clean;
- that access to all parts of the system is safe and satisfactory.

Cleanliness of installation

8.20 During installation it must be established that ductwork is being installed to the 'advanced level' as defined in the HVCA (2005) 'TR/19 – Guide to good practice: internal cleanliness of ventilation systems'. This specifically includes ensuring that ductwork sections arrive on site and are stored with their open ends sealed and that open ends remain sealed during installation to the ingress of builders' dust.

8.21 Should any doubt exist whether the guidance has been observed, the ducts must be cleaned internally to restore them to this standard before being taken into use.

8.22 "Builders work" ducts of brick or concrete must be surface sealed to prevent the release of dust before being taken into use.

8.23 The area around the supply air intake must be free of vegetation, waste, rubbish, builders' debris or any other possible source of contamination.

Certification of equipment

8.24 The following test certificates should be assembled by the commissioning team and be available for inspection at any time during the contract period. They will form part of the handover information and should be placed in the commissioning manual:

- type test performance certificates for fans;
- pressure test certificates for:
  (i) heater batteries;
  (ii) cooling coils;
  (iii) humidifier (if appropriate);

- type test certificates for attenuators;
- type test certificates for primary and secondary filters;
- individual test certificates for high efficiency particulate air (HEPA) filters.

Equipment tests

8.25 Prior to setting the system to work, the checks in paragraphs 8.26-8.28 should be witnessed, and proving tests should be carried out as detailed.

Filters

8.26 The quality of filter housing and in particular, the seals is a critical factor in maintaining the efficacy of the filtration system by ensuring that air does not bypass the filter panels. Therefore, the following checks should be made:

- filter seals should be fitted and in good condition;
- filters should be installed correctly with respect to air flow;
- bag filters should be installed so that the bags are vertical and their pockets free;
- HEPA filters should be installed in a sealed housing and their seals tested to DIN 1946 if specified;
- all filters should be checked to ensure they are free of visible damage;
- the differential pressure indicators should be check for accuracy and that they are marked with the initial and final filter resistance.

Drainage arrangements

8.27 The drain should conform in all respects to the “Design considerations” of this SHTM. In addition the following must be proved:

- that the drain tray is easily removable;
- that a clear trap is fitted and is easily removable;
- that the drain has a clear air gap of at least 15mm;
- that the pipework is supported so that the air break cannot be reduced;
- that the drain system from each drain tray is independent up to the air break;
- that the operation of the drainage system is proved by introducing water into the duct at the drain tray and observing that it completely drains out. This check is to be repeated both at normal speed and set back once the fans have been commissioned. At this time the clear trap can be marked to indicate the normal water level with the fan running.

Fire dampers

8.28 The following must be witnessed and proving tests should be carried out as detailed:

- the operation of all fire dampers; (fire dampers fitted with a thermally actuated “memory metal” mechanism should be proved using a hot air heat source);
- the access provided to enable the dampers to be visually inspected and / or re-set should be sufficient for the purpose;
- indication should be provided of the dampers position (open/tripped);
- indication of the fire dampers location should be provided both on the ductwork and at a visible point on the building fabric if the ductwork is concealed.

Dynamic Commissioning

Air-handling and distribution system

8.29 The fan drive, direction of rotation, speed and current drawn should be set in accordance with their manufacturer’s instructions.

8.30 After the installation has been checked to ensure that it is in a satisfactory and safe condition for start up, it should be set to work and regulated to enable the plant to meet its design specification. The proportional balancing method described in the CIBSE Commissioning Code “A” must be followed. The air-flow rates must be set within the tolerances laid down in the design brief. This will normally be the design air flow rate +10%; -0%.

8.31 When combined supply and extract systems are to be balanced and the area that they serve is to be at or above atmospheric pressure then the supply should be balanced first with the extract fan switched off, and then the extract balanced with the supply fan(s) on.

8.32 For combined systems where the area that they serve is to be below atmospheric pressure then the extract should be balanced first with the supply fan switched off and then the supply balanced with the extract fan on.

8.33 On completion of the balance all volume air-flows in supply and extract ducts and from grilles and diffusers must be measured and recorded. The true air change rate can them be calculated from the data obtained.

8.34 The main supply and extract duct volume control dampers must be locked and their position marked.

8.35 All grille and diffuser volume control registers must be locked to prevent alteration and their final position marked.

Room air distribution

8.36 The pressure relief dampers and pressure stabilisers must be set to achieve the specified room static pressures and locked. The grille direction control vanes and diffuser cones must be set to give the specified air movement pattern. Visualisation techniques may need to be employed in order to prove that the required air flow pattern is being achieved.

Air-conditioning plant

8.37 The specified flow rate and/or pressure drops must be set for all heater batteries, cooling coils and humidifiers. The methods described in the CIBSE Commissioning Codes "W" and "R" should be followed. On completion their regulating devices must be locked to prevent alteration.

Control system

8.38 The control system should not be commissioned until both the air distribution system and air-conditioning equipment have been commissioned.

8.39 Because of the specialised nature of control systems and the fact that each manufacturer's system will contain its own specialist components and settings, the commissioning should be completed by the supplier and witnessed by a representative of the user.

8.40 The location of all control and monitoring sensors should be checked and their accuracy proved.

8.41 The control systems ability to carry out its specified functions must be proved.

8.42 If the plant is provided with a "users" control panel in addition to the one located in the plantroom then the operation of both must be proved. This will typically apply to operating departments and laboratory systems.

Specific Performance Standards

Air movement

8.43 The performance of the system should be measured and compared with information provided by the designer.

Plant capacity and control

8.44 When setting to work and proving the design, both the manufacturer of the air handling plant and the control specialist should attend site together and jointly commission the system.

8.45 If any doubt exists as to the capacity of the installed system, then its ability to achieve the specified inside design conditions with the plant operating at winter and summer outside design conditions must be proved. Artificial loads will be

required in order to simulate the internal gains/losses and the outside design conditions.

8.46 On completion of the plant performance test, recording thermo-hygrographs should be placed in each room/area served by the plant and also the supply air duct upstream of the frost battery. The plant should be run for 24 hours with all doors closed. During this period the inside conditions must stay within the tolerances specified. The BEMS should be used to obtain the information required wherever possible.

Noise levels - General

8.47 The commissioning noise level is the level measured with a sound level meter in the unoccupied room and taking account of the external noise together with the noise generated by the ventilation system. When occupied and in use this commissioning level will constitute a continuous background noise which will allow the overall noise level to be achieved. The ventilation plant design noise level is that generated by the plant alone with no other noise source being considered. The levels suggested make recognised allowance for the ingress of environmental noise.

8.48 The noise levels apply at the maximum velocity for which the system is designed to operate. Acoustic commissioning tests should be carried out with all plant and machinery running normally and achieving the design conditions of air flow, temperature and humidity.

8.49 An industrial-grade sound level meter to BS3489 or IEC 651 Type 2 will normally be sufficient to check the noise level.

8.50 The noise level readings are to be taken at typical normal listening position 1.5m above floor level and at least 1m from any surface and not on any line of symmetry. In critical rooms the noise should be measured at the centre of the room and at the centre of each quarter. The mean of the 5 readings should then be calculated.

8.51 In the event of a contractual deficiency, a Type 1 precision-grade sound-level meter should be used and the noise level determined by the procedure given in Scottish Health Technical Memorandum 08-01.

Filter challenge

General ventilation filters

8.52 In situ performance tests will not normally be required for primary and secondary filters and their housings. However the filters should be visually inspected for grade, tears, orientation and fit within their housing. Filters should be clean and a replacement set available. Bag filters should be installed so that their bags are vertical and spaced so that air can move through them freely. Any filter found to be wet should be replaced and the cause investigated.

HEPA filters (for exhaust protective enclosures and laboratories)

8.53 Pathogenic material may be discharged through damaged or badly installed HEPA terminal filters. The complete installation must be tested using the method set out in BSEN: 14644 'Method of Testing for the Determination of Filter Installation Leaks'.

8.54 The challenge tests may be carried out using either of the following techniques:

- use DOP (Dispersed Oil Generator) to provide the challenge and a photometer to detect leaks;
- use a Discrete Particle Counter (DPC) to detect leaks. In order to obtain a sufficient challenge it may be necessary to remove temporarily the supply AHU secondary filters.

8.55 In both cases the upstream challenge should be measured. A measurement of particle penetration through a representative section of the HEPA filter media is then taken and used as the reference background level. These two readings enable the range of the detecting instrument to be set.

8.56 A challenge aerosol of inert particles of the type produced by a DOP generator should be introduced into the air, upstream of the HEPA filter. The downstream face of the filter, its mounting seal and housing would then be scanned for leakage using a photometer. A leak shall be deemed to have occurred if a steady and repeatable reading on the photometer at any point exceed 0.01% of the upstream reading.

8.57 Alternatively a Discrete Particle Counter (DPC) may be used. For the Discrete Particle Counter method the filter face is sampled at several points to establish the smallest non penetrating particle size. If particles at or above this size are detected when subsequent scans of the filter face, its seal and housing are made, then there is deemed to be a significant leak at, or near, the test position.

8.58 Should the HEPA filter fail this test it must be replaced. Should the filter mounting seal or housing fail this test it may be repaired and the test repeated.

Bacteriological sampling

General ventilation systems

8.59 Bacteriological sampling will not normally be required for either general or local exhaust ventilation (LEV) systems unless otherwise specified.

Conventional operating rooms

8.60 The level of airborne bacteria introduced by the supply air can be checked by closing all doors and leaving the operating room empty with the ventilation system running for 15 minutes. An active air sampler set to 1 cubic metre and mounted on the operating table should then be activated remotely. Aerobic

cultures on non-selective media should not exceed 10 bacterial and/or fungal colony forming units per cubic metre (CFU's/m^3).

8.61 The results should be examined to establish the broad category of organisms present. A high preponderance of fungal organisms may be an indication of inadequate filtration for the particular installation. Precise guidance is inappropriate and will depend on local circumstances.

8.62 It may be appropriate to carry out a check of airborne bacteria during a surgical operation. If required this should be carried out as soon as possible after handover. Unless there are unusually high numbers of personnel or extensive activity in the room, the number of airborne bacterial and/or fungal CFU's averaged over any five minute period, would be unlikely to exceed 180 per cubic metre.

8.63 Information on the additional validation testing of UCV Operating suites is given in Section 8.0(a).

Ventilation System Commissioning/Validation Report

8.64 Following commissioning and/or validation a full report detailing the findings should be produced. The system will only be acceptable to the client if at the time of validation it is considered fit for purpose and will only require routine maintenance in order to remain so for its projected life.

8.65 The report shall conclude with a clear statement as to whether the ventilation system achieved or did not achieve the required standard. A copy of the report should be lodged with the following groups:

- the user department;
- infection control (if required);
- estates and facilities.

8.0(a) Validation of UCV operating suites

General

8.66 Commissioning of a UCV terminal will normally be carried out by its supplier. Commissioning of the air handling unit, fire dampers, distribution ductwork and control systems may be undertaken by different teams. It is therefore important to recognise that the UCV terminal is only one element of the specialised ventilation system serving the operating suite and it cannot be accepted in isolation.

8.67 In order to ensure that the complete system operates correctly it will be necessary to validate the system as a whole from the air intake through to the extract discharge. It is unlikely that "in house" staff will possess the knowledge or equipment necessary to undertake this process. Validation of Ultra Clean

operating theatre ventilation systems should therefore be carried out by a suitably qualified independent Authorised Engineer appointed by the client.

8.68 It is anticipated that training in the validation of specialised healthcare ventilation systems for independent Authorised Engineers will become available during the life of this SHTM.

8.69 The following regime of inspection and testing shall be applied to the validation of new installations designed to provide Ultra Clean conditions in an Operating suite. The test regime has been devised to ensure that the system as installed fully achieves the design requirement for these systems as set out in Section 7.0 (b) of this document.

Basic requirement

8.70 Operating suite to be validated shall be physically complete with final finishes applied. All ventilation systems serving it shall be operating correctly and delivering their design air flow rates.

8.71 In order to avoid preloading the UCV terminal recirculation ducts and HEPA filters, the Operating suite should be free of any obvious dust and at least "builders clean" before the recirculation fans are set to work.

8.72 The validation procedure for a conventional theatre suite shall have been satisfactorily completed to the standard set out in Section 8 prior to attempting to validate the UCV unit. In particular:

- the supply AHU will have achieved the minimum standard;
- the operation of all fire dampers will have been proved;
- the supply and extract air flow rates as measured in ducts and at room terminals will achieve their design values +10%; -0%;
- room differential pressures will be correct.

Evidence of the satisfactory achievement of the forgoing standard should be available for inspection and independently measured as necessary prior to validating the UCV unit.

UCV unit validation procedure

8.73 Tests to validate the suitability and performance of an Ultra Clean Operating suite shall be undertaken in the order that they appear below. Should an item fail to meet the required standard it should be rectified and successfully retested before passing on to the next test.

Summary of test regime

1. Challenge tests to ensure that:
   - the UCV terminal unit is correctly assembled and sealed so that no air will bypass the filters;

- the terminal filters are correctly sealed in their housings;
- the terminal filters are of a uniform quality and undamaged.

2. Air velocity measurements to ensure that
   - a sufficient quantity of air is being delivered by the terminal;
   - the air flow has sufficient velocity to reach the working plane.
3. An entrainment test to ensure that contaminants arising outside of the UCV terminal footprint are not drawn into it.
4. Visualisation techniques to gain an understanding of the overall system performance.
5. Noise measurement to ensure that working conditions are satisfactory.
6. Control system checks to ensure that the system operates as specified.
7. Biological monitoring to determine how effective the system is in use.

Test and Measuring Conditions

8.74 While validating the UCV terminal, the conditions in the Operating room shall be stable and within the given ranges.

Temperature: – 19 - 23°C dry bulb.

Humidity: – 30 – 65% Relative humidity.

Test and Measuring Equipment

8.75 Any test or measuring equipment used should have a certificate to prove that it has been validated within the previous 12 months at a calibration facility using traceable national standards.

8.76 In the case of a noise meter, its “matched sound source” should have a certificate to prove that it has been validated within the previous 12 months at a calibration facility using traceable national standards. The noise meter shall be calibrated to the sound source on each occasion that it is used.

Test Grid – Vertical units

8.77 A test grid shall be constructed on the floor within the Ultra Clean terminal footprint as projected by the inside dimensions of the side walls or boundary air curtain. A suitably marked test sheet will provide a consistent standard of test grid.

8.78 The test grid to comprise test squares of 280mm side.

8.79 The test grid to be aligned along the centre lines of the terminal footprint with its centre under the centre point of the terminal.

8.80 Any test square with 80% of its area within the UCV footprint is to be used as a test position.

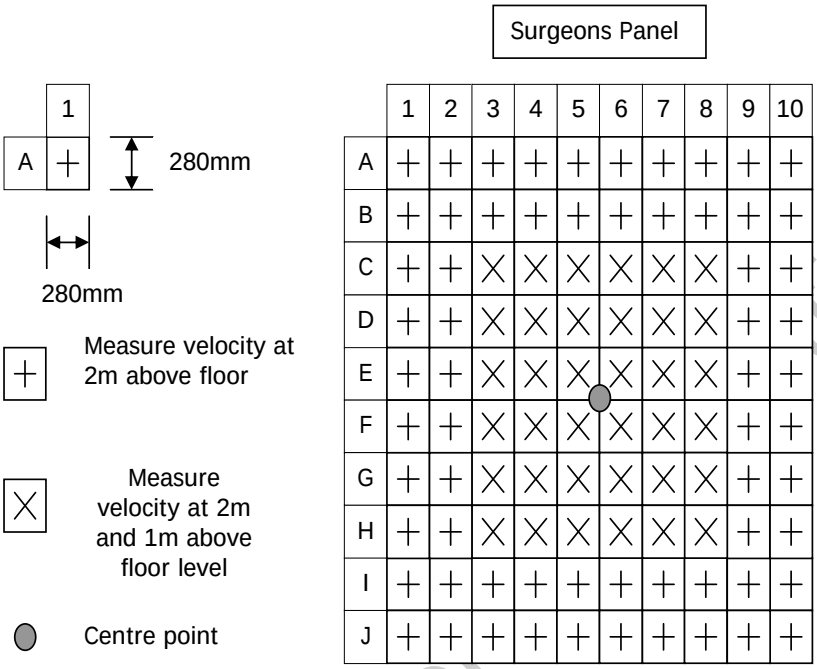
8.81 An inner zone will be designated that is not less than 36% of the total footprint. It will be made up of a number of test squares distributed symmetrically about the terminal footprint centre line. Regardless of the shape of the terminal footprint, the inner zone will comprise a minimum grid of 6 x 6 test squares.

8.82 Unless specified otherwise, a test position shall be in the geometric centre of a test square.

8.83 Test position 1 will be the left most test square in the row nearest to the operating room wall that houses the surgeons panel.

(For an example of a grid for a 2.8 x 2.8 metre terminal see Figure 6)

Figure 6 EXAMPLE of a TEST GRID for a 2.8m x 2.8m UCV TERMINAL



Test Grid – Horizontal units

8.84 A line of test positions shall be marked on the floor 1m in front of the face of the UCV terminal.

8.85 A test position will be marked in the centre of the line. Additional test positions will be marked at 280mm spacing along the line either side of the centre position, up to the full face width of the unit.

UCV Terminal Challenge Tests (Vertical and Horizontal systems)

8.86 The diffuser screen fitted below the face of the terminal HEPA filters should be lowered or removed while the challenge tests are being carried out.

8.87 The installed HEPA filters are to be checked to ensure that their grade accords with the design specification and that their performance has been certified by their manufacturer.

8.88 The challenge tests may be carried out using either of the following techniques:

- use DOP to provide the challenge and a photometer to detect leaks;

- use a Discrete Particle Counter (DPC) to detect leaks. In order to obtain a sufficient challenge it may be necessary to temporarily remove the supply AHU secondary filters.

8.89 In both cases the upstream challenge should be measured. A measurement of particle penetration through a representative section of the HEPA filter media is then taken and used as the reference background level. These two readings enable the range of the detecting instrument to be set.

8.90 For the DOP test this will be set as the 0% reference level and a leak will be declared significant if penetration greater than 0.01% of the range is detected.

8.91 For the Discrete Particle Counter (DPC) method the filter face is scanned to establish the smallest non penetrating particle size. If particles at or above this size are detected when subsequent scans are made then there is deemed to be a significant leak at, or near, the test position.

UCV terminal unit clean zone leak test

8.92 The test will confirm that there is no unfiltered air bypassing the HEPA filter.

8.93 The joints and service penetration points under the UCV terminal within its side walls or boundary air curtain shall be scanned to prove that there are no leaks.

8.94 A leak is defined as a rise above the background level.

Deleted: will be

Terminal HEPA filter seal leak test

8.95 The test will confirm that there is no unfiltered air bypassing the HEPA filter seal.

8.96 Each HEPA filter seal shall be scanned to prove that there are no leaks.

8.97 A leak is defined as a rise above the background level.

Deleted: will be

Terminal HEPA filter media leak test

8.98 The test will confirm that the HEPA filters have not sustained damage while being installed.

8.99 The face of each HEPA filter shall be scanned to prove that there are no leaks.

8.100 A leak is defined as a rise above the background level.

Deleted: will be

Vertical UCV Terminal Air Velocity Tests

Test set up

8.101 The terminal face diffuser screen should be in place for these tests.

8.102 Take spot readings to establish that the room is within the specified temperature and humidity test conditions.

8.103 Set out the test grid as described previously.

8.104 Swing the operating lamp arms and any other stem arms so that they align to present the least resistance to air flow, are perpendicular to the front edge of the test sheet and face the back edge. Any lamp and equipment heads should as far as practicable be outside of the UCV terminal footprint.

Test instrument

8.105 The measuring instrument to be a hot wire anemometer with a digital read out. The instrument resolution to be at least 0·01m/s, have a tolerance of ±0·015m/s or 3% and be calibrated down to 0·15m/s or lower. An alternative instrument may be used providing it is of no lesser specification.

Test method

8.106 The instrument should be mounted on a test stand and set to take a mean reading over a 10 second sample interval.

8.107 It is recommended that a printer be linked to the test instrument so that readings are recorded automatically.

8.108 The test stand to be positioned on each test point in turn and the reading taken when the instrument has stabilised.

8.109 When taking a reading the test person should not stand within the same quadrant as the test instrument.

8.110 Readings are to be taken at the test positions with the instrument probe facing the wall housing the surgeons panel, commencing at the first test position and working along the row from left to right. Readings are taken in the next row also from left to right and so on until half of the test positions have been covered.

8.111 Readings of temperature and humidity are then taken at the specified height in the centre of the terminal. The readouts on the surgeons panel should be recorded at the same time.

8.112 Having completed one half of the test grid, the operating lamp arms and any other stem arms should be swung round through 180^{o} and the test stand reversed so that the wall housing the surgeons panel is behind the test person. Readings are recommenced starting at the right of the test row and working from right to left and so on.

UCV High level discharge velocity test

8.113 Measurements of air velocity are to be taken at every test position 2m above floor level and the results averaged.

8.114 The average of the total readings taken is to be not less than:

0.38 m/s for a partial wall system;

0.30 m/s for a full wall system.

UCV Low level air velocity test

8.115 Measurements of air velocity are to be taken at each of the inner zone test position 1m above floor level.

8.116 The measured velocity at every test position in the inner (operating) zone shall be not less than 0·2m/s.

Horizontal UCV Terminal Air Velocity Test

Test set up

8.117 Set out the line of test positions as described previously.

8.118 Swing the operating lamp arms and any other stem arms so that they align to present the least resistance to air flow and are perpendicular to the line of test positions. (Paragraph 8.106 refers)

Test instrument

8.119 See that specified for vertical systems (paragraph 8.106 refers).

Test method

8.120 The instrument should be mounted on a test stand and set to take a mean reading over a 10 second sample interval.

8.121 It is recommended that a printer be linked to the test instrument so that readings are recorded automatically. Alternatively, they could be downloaded to a computer or data-logger at the end of the test.

8.122 The test stand to be positioned on each test point in turn and the reading taken when the instrument has stabilised.

8.123 When taking readings the test person should stand well downstream of the instrument.

8.124 Readings are to be taken at the test positions with the instrument probe facing the UCV terminal, commencing at the first test position on the left and working along the row from left to right at the specified height.

8.125 The instrument should be reset to the next specified height and the test repeated and so on.

8.126 Readings of temperature and humidity shall be taken at the specified height in the centre of the terminal. The readouts on the surgeons panel should be recorded at the same time.

UCV discharge velocity test

8.127 Measurements of air velocity are to be taken at all test positions at 1m, 1·5m and 2m above floor level.

8.128 The average of the total readings taken is to be no less than 0·4m/s.

Deleted: A reading of temperature and humidity should be taken 1·5m above floor level at the centre test position. The readouts on the surgeons panel should be recorded at the same time.¶

UCV Entrainment Test (Vertical systems only)

Rationale for the entrainment test

8.129 The performance of UCV systems may be compromised by room air being drawn into the ultra-clean airflow, a phenomenon known as entrainment. Significant levels of entrainment could lead to microbial contamination of items left exposed on instrument trolleys laid out beneath the canopy.

8.130 UCV systems having permanently fitted full side walls do not need to be tested as the side walls physically prevent entrainment.

Principle of the test

8.131 A source of particles is produced outside of the UCV terminal and is used to challenge the system. A detector is placed within the ultra-clean airflow and used to determine the percentage penetration of the test particles at predefined locations under the UCV terminal footprint. The source and detector are moved in tandem around the UCV canopy and pairs of readings taken, from which the percentage penetration at specified locations is calculated. The degree of penetration should be below specified maximum limits if entrainment is to be declared not significant.

8.132 The entrainment test may be carried out using either of the following techniques:

- use DOP to provide the challenge source at the specified release position and a photometer to measure the entrainment; or
- duct non HEPA filtered air to the specified release position and use a particle counter to measure the entrainment.

Test set up

8.133 The terminal face diffuser screen should be in place for these tests.

8.134 The test is performed without any equipment in place beneath or closely adjacent to the UCV terminal.

8.135 The theatre lights should be moved to a central position beneath the terminal and raised to 2m above floor level, so as not to interfere with the peripheral airflows.

8.136 Take spot readings at the centre of the canopy, one metre from floor level, to establish that the room is within the specified temperature and humidity test conditions. (Paragraph 8.75 refers).

8.137 Set out the test grid as described previously.

8.138 For either of the following entrainment tests, a measurement of particle penetration through a representative section of the HEPA filter media is to be taken and used as the reference background level.

Test equipment, challenge source, measuring instrument and detector head

8.139 The challenge and detector equipment should be chosen so that:

- the tracer particles are mainly within the size range 0.3 to 5 microns and thus capable of remaining airborne for a substantial time;
- the particles used should not be able to penetrate the terminal filters in sufficient numbers to cause a background count that is more than 0.1% of the challenge count;
- the choice of particle and detector will enable a minimum of 3 logarithm (1,000-fold) range of counts to be recorded between the highest (i.e. source) and lowest (i.e. background) readings expected. A concentration of approximately 10^5 particles per cubic metre of source air has been shown to be adequate.

Source – Dispersed Oil Particles (D.O.P.)

8.140 The DOP generator should be able to produce a cloud of test particles in the from of a visible smoke. The test smoke should be delivered via an aperture so that it flows vertically downward from the lowermost edge of the partial wall, on the outside of the UCV canopy.

8.141 The test smoke is to be delivered via an aperture.

Note: To prevent undue contamination of the theatre and filters with deposits of oil, it is recommended that the above rates of generation of challenge smoke should not be exceeded by more than a factor of three.

Source – natural particles

8.142 The sourse unit should be a fan/blower or other method that takes non-HEPA filtered air and expels it via a delivery head at the specified release position to provide the particle challenge. The challenge air should be delivered vertically downwards from the lowermost edge of the partial wall, on the outside of the UCV canopy, parallel to the airflow coming from the diffusers. The challenge air

velocity should be the same as the measured average velocity at 2m from the terminal under test.

Note: The use of DOP for testing is gradually being phased out and replaced by a natural challenge measured with a DPC. At the time of writing research is under way to define more precisely a challenge source unit for natural particles. It is anticipated that such a unit, together with a matching test methodology, will become available during the life of this Scottish Health Technical Memorandum.

The detector (defined in terms of range and resolution)

8.143 This may be a photometer or a DPC. It is recommended that a printer be linked to the test instrument so that readings are recorded automatically. The instrument should be capable of sampling a minimum a 28.3 litres of air per minute and in the case of the DPC, provide readings for particle size ranges from 0.3 microns to 5.0 microns and greater. The instrument should be compliant with the requirements of BS EN ISO 14644-1. An alternative instrument may be used providing it is of no lesser specification.

Test positions and orientation of source and detector

8.144 The test positions will be at the centre of each test square, as defined for the velocity test. (see section 8 paragraphs 102-128).

8.145 For rectangular UCV terminals, measurements of penetration are to be taken at the four corner test squares of the test grid and at intermediate positions along the line of test squares between the corners. The number of intermediate test positions will be as equally spaced as possible around the periphery with not less than 3 and not more than 5 complete test squares between test positions.

8.146 A further series of measurements are to be obtained around the periphery of the inner zone (defined in paragraph 8.82). Measurements of penetration are to be taken at the four corner test squares of the inner zone of the test grid and if necessary at intermediate positions along the line of test squares between the corners as equally spaced as possible, with not less than 3 and not more than 5 complete test squares between test positions.

8.147 A single measurement will be taken at the geometrical centre of the UCV terminal footprint. The centre measure measurement will be taken with the detector head mounted vertically 1 meter above floor level.

8.148 The centre of the challenge particle source is aligned with the centre of the designated test square, with its longer edge against the outer edge of the partial wall and delivering the challenge from the lower edge of the partial wall. The air containing challenge particles is directed vertically downward from the lower edge of the partial wall, in a plane parallel to the adjacent partial wall. Where there is physical interference due to obstructions such as gas pendants, the source will be moved to the next available non obstructed test square location nearest to the stipulated sampling position. The detector will then also be moved to remain opposite the source.

8.149 In the case of non rectangular terminals, an interpretation of the above strategy should be adopted that will yield a no less searching examination of the unit's ability to control entrainment.

Test method

8.150 The sampling head of the detector instrument is mounted on a test stand with its sampling orifice facing outwards horizontally from the centre of the UCV canopy, 1m above floor level. The sampling head will be orientated at right angles to the partial wall when sampling along the sides of the test grid but will be set to bisect the angle when measuring at the corner test positions (Figure 6 in section 8, at paragraph 8.84 illustrates the challenge and detector orientations when evaluating a 2.8m x 2.8 m UCV terminal).

8.151 The test will commence at the first test position, this being designated the leftmost corner of the test grid when facing the wall housing the surgeons panel. The penetration will also be measured at the corresponding test point on the inner zone commencing at the corner nearest to the first test position. When these tests have been completed, the source and detector equipment will be moved to the next test positions, working around the test grid in a clockwise direction.

8.152 The test stand will be positioned on each test point in turn and a pair of readings (challenge, then penetration) taken when the instrument has stabilised. The detector should be set to take a reading over a 15 second sample interval.

8.153 When taking a reading the test person should stand within the UCV terminal footprint but not in the same quadrant as the detector head.

Measuring the challenge

8.154 With the down flow from the source shielded from the ultra-clean airflow from the canopy, an estimate of the particle concentration/numbers in the challenge air is made, averaged over a minimum of sample time of 15s. An estimate is obtained at each of the test locations, immediately prior to measuring the penetration beneath the canopy. Where the detector system reads directly as a concentration, or as a percentage, then a steady reading of the challenge should be obtained over a minimum of 15s and this reading should be taken as (or set to) 100%.

Analysis and interpretation

8.155 The following standard is to be achieved:

- penetration to be not greater than 10% of the challenge background at each test position in the outer zone;
- penetration to be no grater than 1% of the challenge background at each test position in the inner zone;
- penetration to be no greater than 0·1% of the challenge at the centre of the test grid.

If a result is close to, or above the given limits, then a further reading must be obtained using a longer time base (1 minute) and the penetration must not exceed the given limit.

Basis of the test

8.156 Whyte W, Shaw BH, Freeman MAR. An evaluation of a partial-walled laminar-flow operating room. *J Hyg Camb* 1974 ; 73 : 61 – 75.

Whyte W, Lidwell OM, Lowbury EJL, Blowers R. Suggested bacteriological standards for air in ultraclean operating rooms. *J Hosp Infect* 1983 ; 4 : 133 – 139.

UCV Visualisation

8.157 The use of smoke to gain an understanding of the overall performance of the system may prove useful at this stage in the validation process but cannot be relied on to produce a contractually definitive measure of performance.

UCV Noise Level

8.158 An industrial-grade sound level meter to BSEN 61672 Type 2 fitted with a muff will be used to check the noise level. The instrument shall be calibrated using a matched sound source prior to each set of readings.

Vertical systems

8.159 The noise level readings are to be taken at typical normal listening position 1·5m above floor level and at least 1m from any surface and not on any line of symmetry. Measurements should be taken under the centre of each quadrant of the UCV terminal and the four readings averaged.

Horizontal systems

8.160 The noise level readings are to be taken at typical normal listening position 1·5m above floor level on the test line. The width of the unit should be divided in two and a measurement taken in the centre of each half but avoiding any line of symmetry. The two readings should be averaged.

8.161 Measurements shall also be taken in each room of the suite.

8.162 In the event of a contractual deficiency a Type 1 precision-grade sound level meter complying with BS EN 61672 should be used. Readings should be taken at the positions specified above and in each case the logarithmic mean of the results should be calculated in order to determine the noise level.

8.163 For vertical or horizontal systems, the noise level shall not exceed:

- 50NR [55Db(A)] – for UCV operating rooms and spaces without doors that open directly on to it (for example the scrub);
- 40NR [45Db(A)] – for all other peripheral rooms of the suite.

UCV Control System Checks

Temperature

8.164 The readings of temperature taken under or in front of the UCV unit shall be within ±1°C of each other and the readout on the surgeons panel.

Humidity

8.165 The readings of humidity taken under or in front of the UCV unit shall be within ±5% of each other and the readout on the surgeons panel.

Direct reading differential pressure gauges

8.166 The differential pressure across the terminal filter should be measured to confirm the accuracy of the indicated reading of any gauge.

Control functions

8.167 The operation of all control functions provided on the surgeons panel should be proved for conformity with the design specification.

8.168 If an auxiliary panel has been fitted then its interlocking with the main surgeons panel control functions must be proved to conform to the design specification.

Panel indicator lights

8.169 The panel indicator lights should illuminate as appropriate when the control functions are selected or warning levels are reached

BEMS interface

8.170 The operation, monitoring and alarm functions must be proved to conform with that set out in the design specification.

UCV Theatre Microbiological Tests

8.171 There is little value in performing microbiological sampling in a new theatre supplied with ultra clean ventilation. The foregoing filter challenge tests, air velocity measurements and entrainment test should have proved that the system operates satisfactorily and achieves the contracted level of performance. The HEPA filters will remove bacteria sized particles from the air supplied through the UCV terminal. Therefore there will be an insignificant

number of bacterial and/or fungal CFU's present until the Theatre is actually used.

8.172 The installation should be tested during surgical procedure at intervals between the time of the first incision and final closure of the wound. On average, the air sampled within 300mm of the wound should not contain more than 10 CFU/cubic metre.

UCV Validation Report

8.173 Following validation a full report detailing the findings should be produced. The report shall conclude with a clear statement as to whether the UCV theatre suite achieved or did not achieve the standard set out above.

8.174 A copy of the report should be lodged with the following groups:

- operating department;
- infection control;
- estates and facilities.

Appendix 1 – Table A1

Application	Ventilation	AC/Hour	Pressure (Pascals)	Supply Filter	Noise (NR)	Temp (oC)	Comments For further information see Section 6
General ward	S / N	6	-	G4	33	18-28	
Communal ward toilet	E	10	-ve	-	45	-	
Single room	S / E / N	6	0 or –ve	G4	33	18-28	
Single room WC	E	3	-ve	-	45	-	
Clean utility	S	6	+ve	G4	45	18-28	
Dirty utility	E	6	-ve	-	45	-	
Ward Isolation room	-	-	-	-	-	-	See HBN 4; Supplement 1
Infectious disease Iso room	E	10	-5	G4	33	18-28	Extract filtration may be required
Neutropeanic patient ward	S	10	+10	H12	33	18-28	
ITU / HDU	S	10	+10	G7	33	*18-25*	Isolation room may be –ve press
Maternity delivery room	S & E	15	-ve	G4	45	*18-25*	Provide clean air flow path
SCBU	S	6	+ve	F7	33	*18-25*	Isolation room may be –ve press
Preparation room (Lay up)	S	>25	35	F7*	50	*18-25*	*H12 if a lay up for a UCV Theatre
Preparation room / bay (SPS)	S	25	25	F7	50*	*18-25*	*55NR if a bay in a UCV Theatre
Operating theatre	S	25	25	F7	50	*18-25*	
UCV Operating theatre	S	25	25	H12	55	*18-25*	Fresh air rate; excludes re-circulation
Anaesthetic room	S & E	15	12	F7	50	*18-25*	Provide clean air flow path
Sluice	E	>20	-5	-	50	-	
Recovery room	S & E	15	0	F7	45	*18-25*	Provide clean air flow path
Cardiac catheterisation lab	S	15	+ve	F7	50	*18-22*	
Endoscopy room	S	15	+ve	F7	50	*18-25*	
Endoscopy cleaning	E	>10	-ve	-	50	-	

Day case theatre	S	15	+ve	F7	50	*18-25*	
Treatment room	S	10	+ve	F7	45	*18-25*	
Pharmacy aseptic suite	S	20	#	H14	50	*18-22*	# See GGMP (Orange guide)
Cat 3 containment room	#	>20	#	H14*	50	*18-22*	# See ACDP guide; *Filter in extract
Post mortem room	S & E	S = 10 E = 12	-ve	G4	50	18 –22	Provide clean air flow path
Specimen store	E	-	-ve	-	-	-	Fan accessible from outside of store

Appendix 2 – Hierarchy of Cleanliness

Table A2

			Air flow rate for bacterial contaminant dilution	
Class	**Room**	**Nominal pressure Pa (A)**	**Flow in or supply m^3/s**	**Flow out or extract m^3/s**
Sterile	Preparation room (a) lay-up (b) sterile pack store Operating room Scrub bay/(B)	 35 25±5 25 25	See standard schemes in Appendix 3 for recommended design values	
Clean	Central sterile pack store Anaesthetic room (C) Scrub room	14 14 14	0.10 The greater of 15 AC/hr or 0.15 -	- The greater of 15 AC/hr or 0.15 0.10
Transitional	Recovery room Clean corridor General access corridor Changing rooms Plaster room	3 0 0 3 3	15 AC/hr(C) (D) (D) 7 AC/hr 7 AC/hr	15 AC/hr(C) 7 AC/hr 7 AC/hr 7 AC/hr 7 AC/hr
Dirty	Service corridor Disposal room	0 -5 or 0	- -	(E) 0.10

Notes:

a. Nominal room pressures are given to facilitate setting up of pressure relief dampers, the calculation process, and the sizing of transfer devices. In practice the resultant pressures are not critical provided the desired air movement is achieved.

b. An open or semi-open bay is considered to be part of the operating room, and provided air movement is satisfactory, no specific extract is required. However if the layout means that air movement is poor, a local extract may be required to control local condensation on the building surfaces which can result in mould growth.

c. 15 AC/hr is considered necessary for the control of anaesthetic gas pollution.

d. Supply air flow rate necessary to make up 7 AC/hr after taking into account secondary air from cleaner areas.

e. No dilution requirement. Temperature control requirements only.

Table A3 – Leakage flows in m^3/s through closed door gaps

Type	Pressure difference - Pa						
	5	**10**	**15**	**20**	**25**	**30**	**40**
Single door (CDB Size 2.4.3.2.6.)	.03	.05	.06	.06	.07	.07	.08
Double door (CDB)	.04	.08	.10	.11	.12	.13	.14
High permanent length of 3mm gap	.004	.008	.010	.011	.012	.012	.013

Note: CDB = Component Data Base

It should be noted that many doors are now fitted with cold smoke seals as standard. These will significantly reduce the door leakage rate when new and undamaged. It is therefore recommended that provision for the design leakage be factored into the sizing of the appropriate transfer grille or pressure stabiliser. Failure to do this will result in air gap whistles and doors being held partially open by air pressure.

Table A4 - Recommended air flow rates in m^3/s through a doorway between rooms of different cleanliness to control cross-contamination

Room class		Dirty	Transitional	Clean	Sterile
Sterile	Hatch Single door Double door	0.3 0.47 0.95	0.24 0.39 0.75	0.18 0.28 0.57	 0 or 0.28 (C) 0 or 0.57 (C)
Clean	Single door Double door	0.39 0.75	0.28 0.57	0 or 0.28 (C) 0 or 0.57 (C)	
Transitional	Single door Double door	0.28 0.57	0 or 0.28 (C) 0 or 0.57 (C)		
Dirty	Single door Double door	0 0	Open single door = 0.80m x 2.01m high Open double door = 1.80m x 2.01m high		

Notes:

A. The degree of protection required at an open doorway between rooms is dependent upon the degree of difference in cleanliness between them.

B. Flow rate required between rooms within the same class tends to zero as class reduces.

C. If two rooms are of equal cleanliness, no flow is required (in practice there will be an interchange in either direction) and the design of the air movement will assume zero air flow. In certain cases, however, interchange is not permitted and a protection air flow of 0.28 is assumed in the design, for example, in the case of a preparation room used as a "lay up".

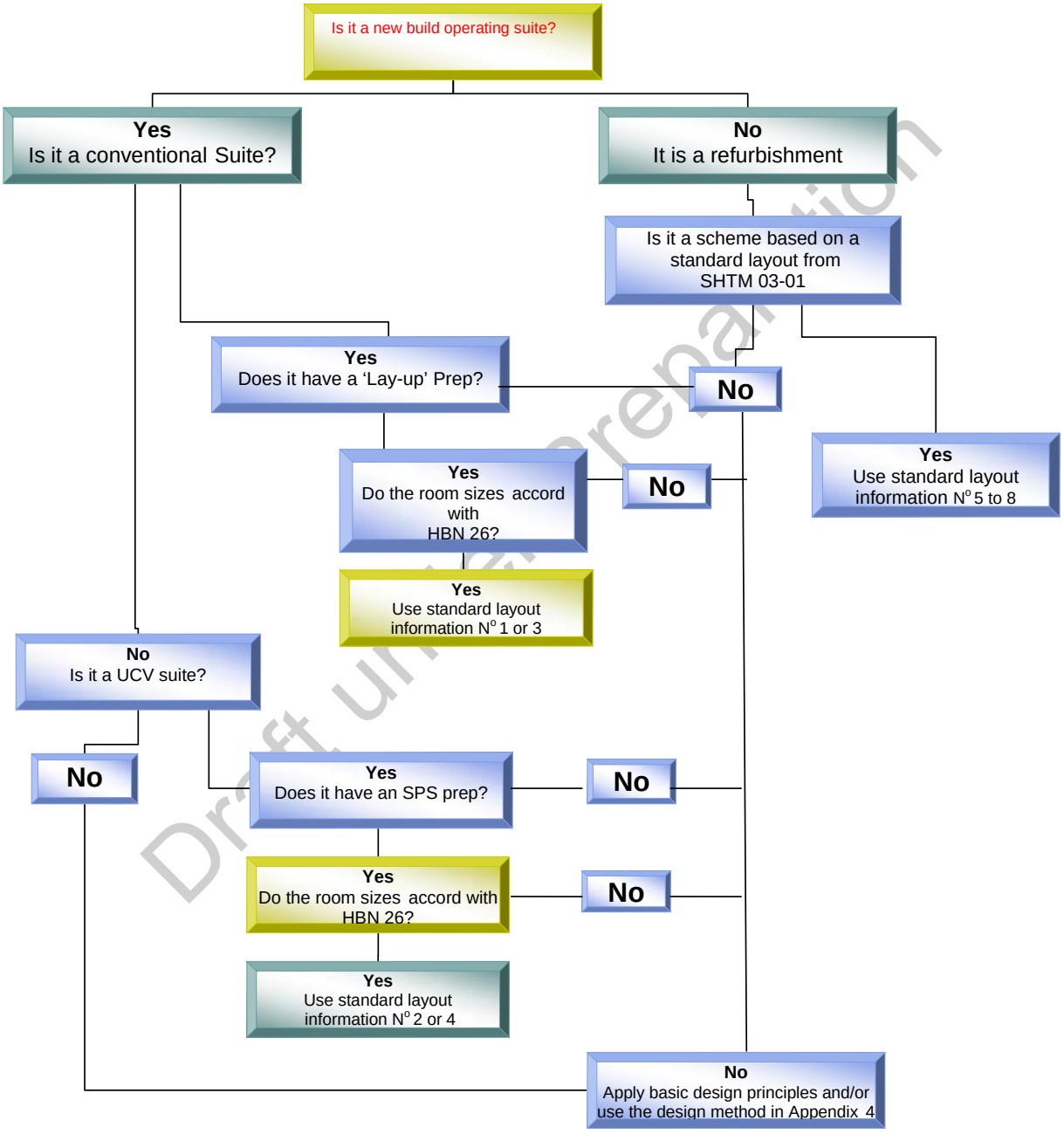
Table A5 - Typical pressures in an operating suite when a given door is open

		Effect on other rooms	
Door open between	Resultant pressure in these rooms	Room	Pressure (Pa)
Operating room and corridor or Scrub bay and corridor	0 Pa	Anaesthetic Preparation – lay up Disposal Preparation – sterile pack store	0 12 -6 5
Operating room and anaesthetic room (or other series room with double doors)	17 Pa	Preparation – lay up Disposal Preparation – sterile pack store	26 -9 22
Operating room and disposal room or Operating room and preparation room	25 Pa	No change	
Anaesthetic room and corridor (or other series room with double doors)	0 Pa	Preparation – lay up Disposal Operating room Preparation – sterile pack store	30 -6 20 25
Preparation room – corridor Disposal room - corridor	0 Pa	No change	
Disposal room – outer corridor	0 Pa	No change	

Notes:-

1. The room differential pressure protects against reverse flows when the door is closed.
2. The flow of air through a doorway protects against reverse air flow when the door is open.
3. Pressure stabilisers control flow and ensure a known air flow path between rooms when doors are closed and reduce back flow between rooms when doors to other rooms are open.

Appendix 3 – Operating suite design logic



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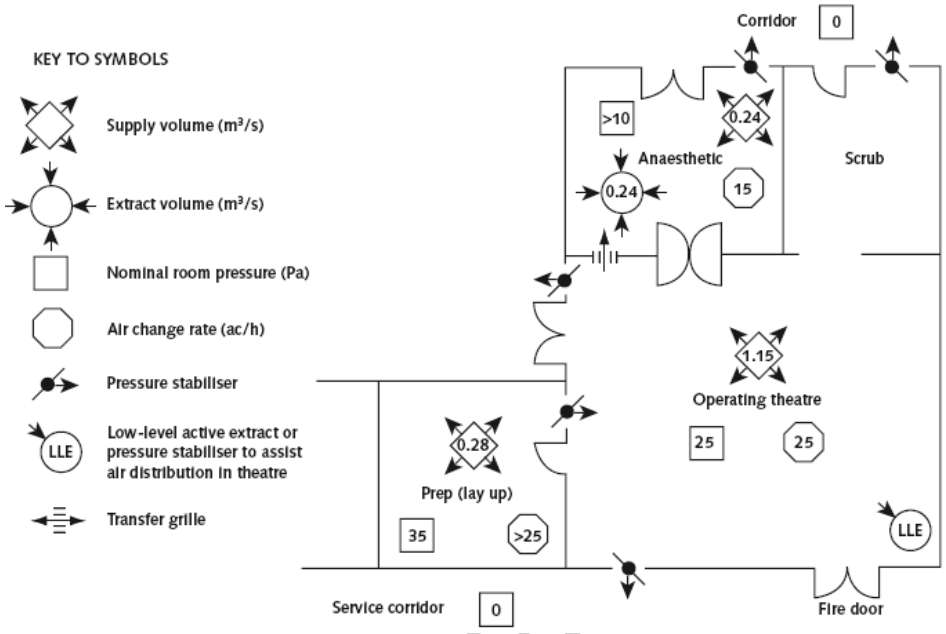
New Standard Layout N° 1 - Suitable for a typical Conventional theatre suite (Room sizes as specified in HBN 26)



Room	Size m³ Derived from HBN26	Air Change Rate per hour	Nominal Pressure Pa	Flowrate m³/s
Theatre	165	25	25	1.15
Anaesthetic	57	15	14	0.24
Lay Up Prep	36	>25	35	0.28**
Scrub*	33	25	25	0.23

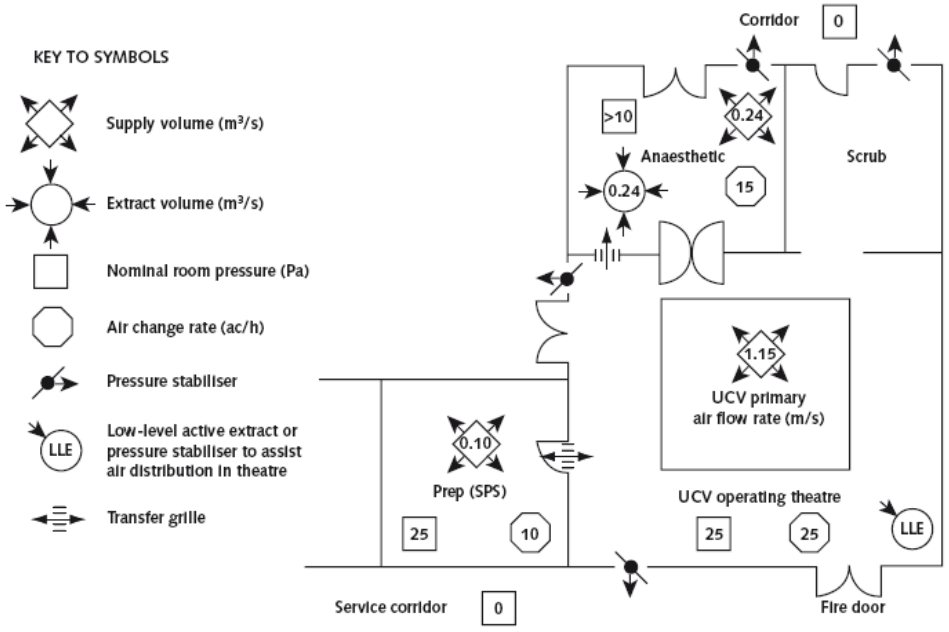
*Scrub will be considered as part of theatre.

**Interchange is not permitted between the theatre and lay-up prep; therefore an airflow protection of 0.28 + 0.06 closed-door airflow is required as a minimum.

The volume of air to be extracted from the theatre should be determined by subtracting the airflow required for door protection at the exits from the total air entering the theatre space. The balance should be equally divided between the passive or active extract locations.

The extracts within the theatre may be either passive and fitted with pressure stabilizers or active and connected to the extract system. They should be located at low level and positioned to promote the ventilation of all areas of the space.

New Standard Layout N° 2 - Suitable for a typical UCV theatre suite (Room sizes as specified in HBN 26)



Room	Size m³ Derived from HBN26	Air Change Rate per hour	Nominal Pressure Pa	Flowrate m³/s
Theatre	165	25	25	1.15**
Anaesthetic	57	15	14	0.24
Sterile Prep	36	25	25	0.25
Scrub*	33	25	25	0.23

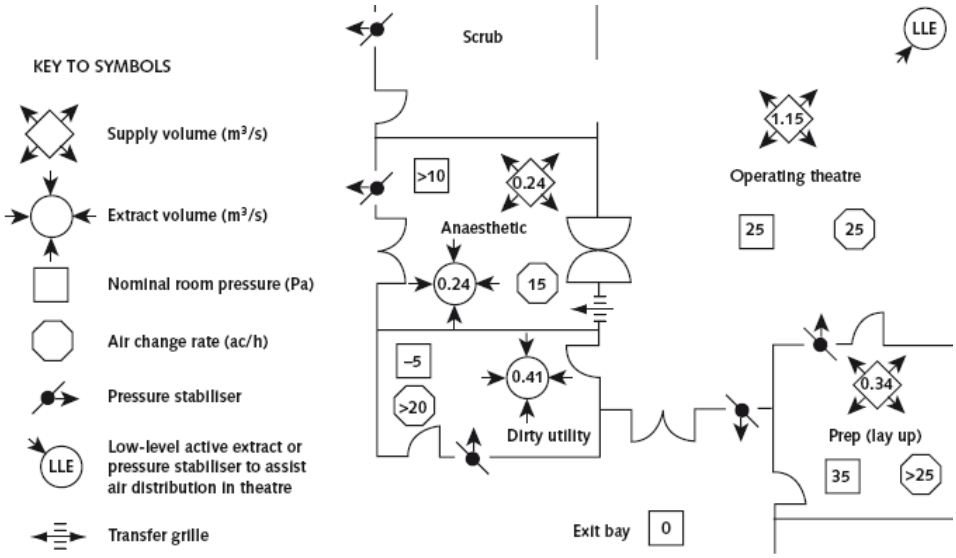
*Scrub will be considered as part of theatre

**Primary Fresh air Volume Only

The volume of air to be extracted from the theatre should be determined by subtracting the airflow required for door protection at the exits from the total air entering the theatre space. The balance should be equally divided between the passive or active extract locations.

The extracts within the theatre may be either passive and fitted with pressure stabilizers or active and connected to the extract system. They should be located at low level and positioned to promote the ventilation of all areas of the space.

New Standard Layout N° 3 - Suitable for a typical Conventional theatre suite (Layout and room sizes are as illustrated in HBN 26)



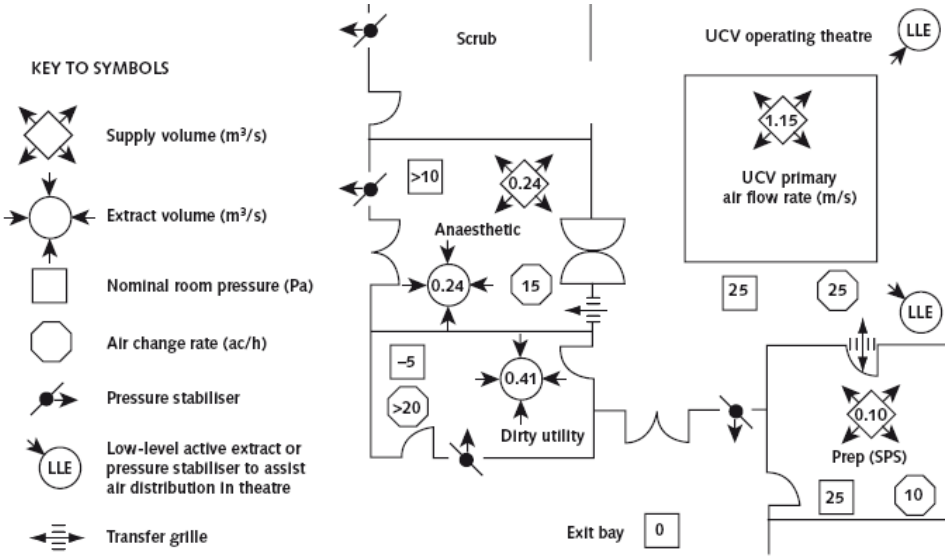
Room	Size m³ Derived from HBN26	Air Change Rate per hour	Nominal Pressure Pa	Flowrate m³/s
Theatre	165	25	25	1.15
Anaesthetic	57	15	14	0.24
Lay Up Prep	36	>25	35	0.34**
Scrub	33	25	25	0.23
Dirty Utility	36	-	-5	0.41

**Interchange is not permitted between the theatre and lay up prep therefore as table 4 an airflow protection of 0.28 + 0.06 closed door air flow is required as a minimum.

The volume of air to be extracted from the theatre should be determined by subtracting the airflow required for door protection at the exits from the total air entering the theatre space. The balance should be equally divided between the passive or active extract locations.

The extracts within the theatre may be either passive and fitted with pressure stabilizers or active and connected to the extract system. They should be located at low level and positioned to promote the ventilation of all areas of the space.

New Standard Layout N° 4 - Suitable for a typical UCV theatre suite (Layout and room sizes are as illustrated in HBN 26)



Room	Size m³ Derived from HBN26	Air Change Rate per hour	Nominal Pressure Pa	Flowrate m³/s
Theatre	165	25	25	1.15**
Anaesthetic	57	15	14	0.24
Sterile Prep	36	25	25	0.25
Scrub	33	25	25	0.23
Dirty Utility	36	-	-5	0.41

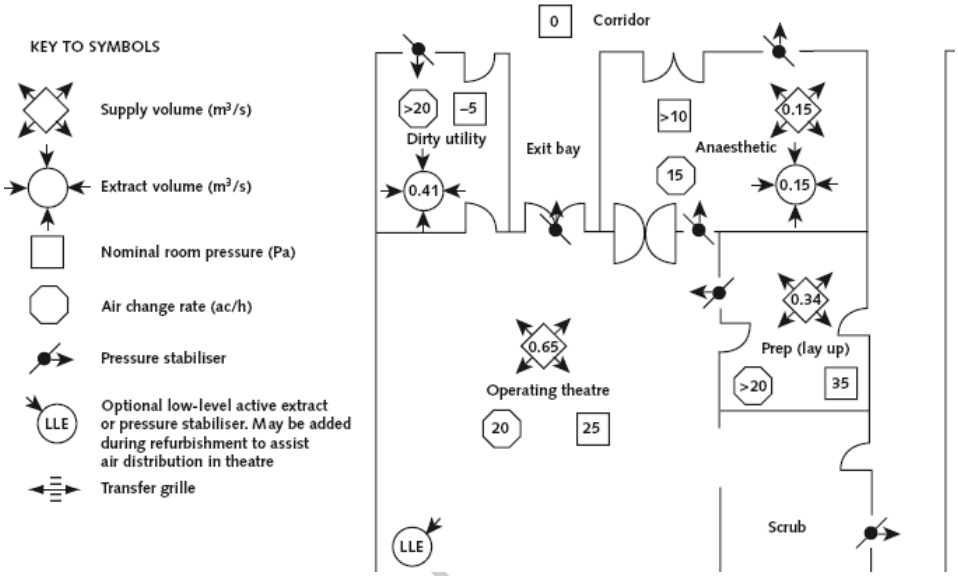
**Primary Fresh air Volume Only

The volume of air to be extracted from the theatre should be determined by subtracting the airflow required for door protection at the exits from the total air entering the theatre space. The balance should be equally divided between the passive or active extract locations.

The extracts within the theatre may be either passive and fitted with pressure stabilizers or active and connected to the extract system. They should be located at low level and positioned to promote the ventilation of all areas of the space.

New Standard Layout N° 5 - SHTM 03-01 Existing Standard Plan '1b' Typical layout for a Conventional theatre suite

This layout and data is for historical purposes only. The information is to be used for the evaluating of existing systems or rebalancing following ventilation system cleaning.

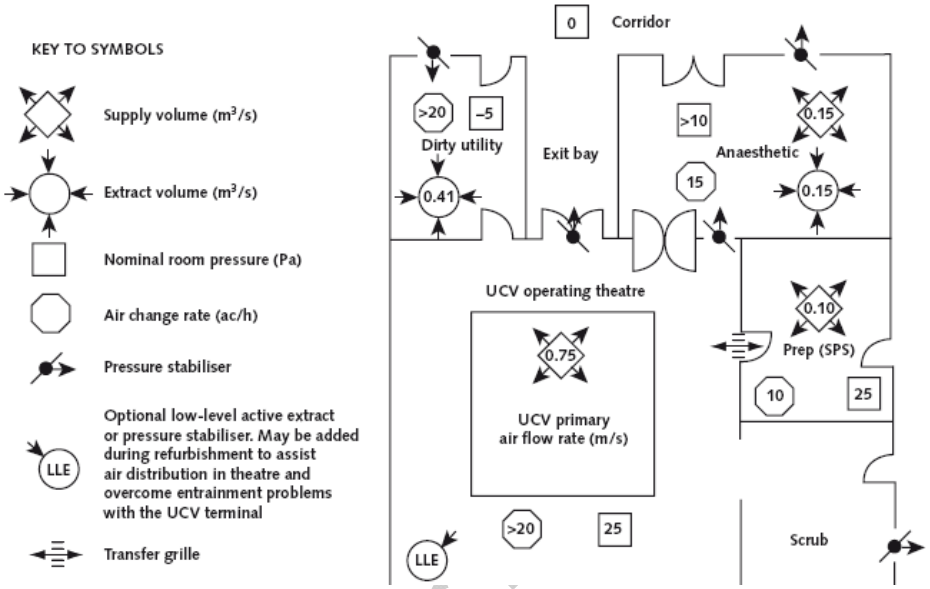


Room	Size m³ Derived from HBN26	Air Change Rate per hour	Nominal Pressure Pa	Flowrate m³/s
Theatre	Existing Theatre Suite To Be Measured On Site	20	25	0.65
Anaesthetic		15	14	0.15
Lay Up Prep		-	35	0.33
Scrub		20	25	Included within theatre
Disposal		-	-5	0.41

The disposal layout detailed will remain the same should a hatch be utilised instead of a door onto the outer corridor.

New Standard Layout N° 6 - SHTM 03-01 Existing Standard Plan '1a' Typical layout for a UCV theatre suite

This layout and data is for historical purposes only. The information is to be used for the evaluating of existing systems or rebalancing following ventilation system cleaning.



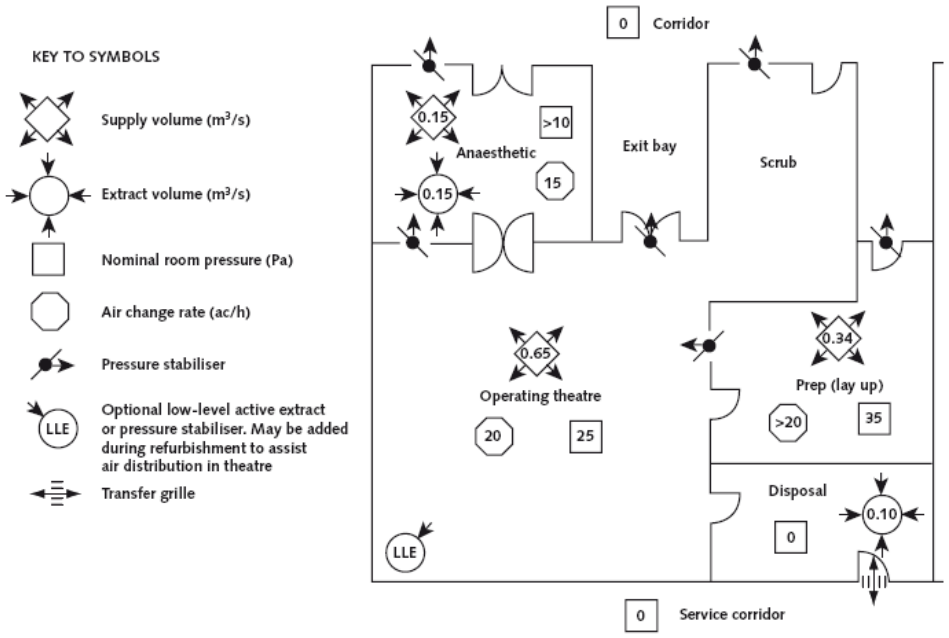
Room	Size m³ Derived from HBN26	Air Change Rate per hour	Nominal Pressure Pa	Flowrate m³/s
Theatre	Existing Theatre Suite To Be Measured On Site	20	25	0.75*
Anaesthetic		15	14	0.15
Sterile Prep		-	25	0.1
Scrub		20	25	Included within theatre
Disposal		-	-5	0.41

*Primary fresh air flow volume

The disposal layout detailed will remain the same should a hatch be utilised instead of a door onto the outer corridor.

New Standard Layout N° 7 - SHTM 03-01 Existing Standard Plan '1b' Typical layout for a Conventional theatre suite

This layout and data is for historical purposes only. The information is to be used for the evaluating of existing systems or rebalancing following ventilation system cleaning.

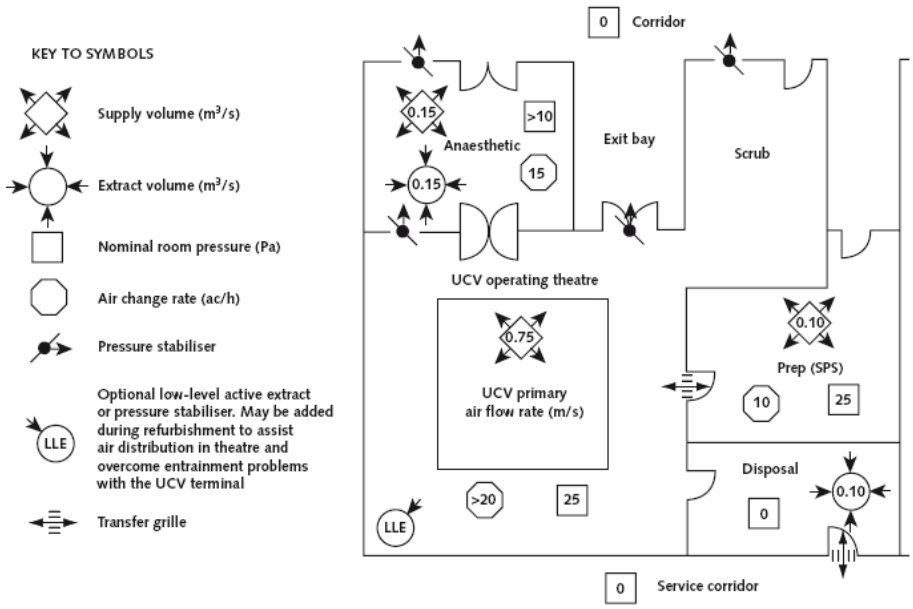


Room	Size m³ Derived from HBN26	Air Change Rate per hour	Nominal Pressure Pa	Flowrate m³/s
Theatre	Existing Theatre Suite To Be Measured On Site	20	25	0.65
Anaesthetic		15	14	0.15
Lay Up Prep		-	35	0.34
Scrub		20	25	Included within theatre
Disposal		-	0	0.1

The disposal layout detailed will remain the same should a hatch be utilised instead of a door onto the outer corridor. Alternatively the disposal room could be omitted and replaced with a disposal hatch between the theatre and corridor.

New Standard Layout N° 8 - SHTM 03-01 Existing Standard Plan '5a' Typical layout for a UCV theatre suite

This layout and data is for historical purposes only. The information is to be used for the evaluating of existing systems or rebalancing following ventilation system cleaning.



Room	Size m³ Derived from HBN26	Air Change Rate per hour	Nominal Pressure Pa	Flowrate m³/s
Theatre	Existing Theatre Suite To Be Measured On Site	20	25	0.75*
Anaesthetic		15	14	0.15
Sterile Prep		-	25	0.1
Scrub		20	25	Included within theatre
Disposal		-	0	0.1

*Primary fresh air flow volume only

The disposal layout detailed will remain the same should a hatch be utilised instead of a door onto the outer corridor. Alternatively the disposal room could be omitted and replaced with a disposal hatch between the theatre and corridor.

Appendix 4 - Design of air-movement control schemes for operating theatres.

General

A4.1 Standard operating suite design solutions are given in Appendix 3. If these standard solutions cannot be used, the following procedure should be adopted, which will result in an acceptable design. Note that the method employed can equally be used to provide a design solution to a ventilated suite of rooms for any application.

A4.2 The method is concerned with the calculation of air-flow rates to ensure that correct air movement occurs between rooms when any one door is open. Under most circumstances, the air quantities required for air-movement control will approximate to those for either temperature control or bacterial contaminant dilution. This flow rate is sufficient to control the effects of any slight reverse flows occurring when a door is opened.

A4.3 The progression through the design procedure is shown in the air-flow design procedure chart (Figure A4/3) and is supported by worksheets WS1 to WS7 described in paragraph A4.4. It is recommended that a plan of the suite and an air-flow network be made (Figure A4/2) to collate all information. Flow rates, air-transfer devices etc should be entered as required. The remainder of this Appendix may be treated as reference data to assist in the various steps. The following symbols are used:

S_S – supply air-flow rate for summer temperature control;

S_W – supply air-flow rate for winter temperature control;

S_D – supply air-flow rate for dilution of bacterial contaminants;

S_L – supply air-flow rate for heat loss;

S_G – supply air-flow rate for heat gain;

E_D – extract air-flow rate for dilution of bacterial contaminants;

S_F – final supply air-flow rates;

E_F – final extract flow rates;

S_{AMC} – air-supply flow rate for air-movement control;

E_{AMC} – air-extract flow for air-movement control;

L_{OUT} – leakage air-flow rate outward;

L_{IN} – leakage air-flow rate inward;

$\sum_{OUT}$ – total air-flow rate outward;

$\sum_{IN}$ – total air-flow rate inward.

A4.4 To simplify the procedure, standard worksheets (WS1 to WS7) have bgeen devised. For each operating suite, a set is required comprising one each of WS1, WS3, WS5, WS6a, WS6b and WS7, one WS4 for each corridor and one WS2 to cover each peripheral room. WS2 has five versions:

- WS2a single flow;
- WS2b parallel/series multi-flow;
- WS2c parallel multi-flow or series multi-flow (unbalanced);
- WS2d series multi-flow (balanced); and
- WS2e bay (semi-open).

Peripheral room type

A4.5 The rooms in the operating suite other than the operating room and corridor are referred to as peripheral rooms. Peripheral rooms have been classified according to the flows in and out. These room classifications are defined below in paragraphs A4.6 – A4.11.

Single flow

A4.6 This is a room with only one door and a net surplus of supply or extract air.

Parallel multi-flow

A4.7 This is a room with two or more doors through each of which the air flows either outwards (high pressure) or inwards (low pressure) (for example the Prep (lay-up) in standard layout 5 in Appendix 3).

Parallel/series multi-flow

A4.8 This is a room having a net surplus of supply or extract and with two or more doors. One or more doors will be to an area of equal cleanliness and need not be protected; hence, the flow may vary between inwards and outwards, the remaining door being to an area of greater or lesser cleanliness (for example the Prep (SPS) in standard layout 6 in Appendix 3).

Series multi-flow (unbalanced)

A4.9 This is a room having a net surplus of supply or extract and with two or more doors. Air flows inwards through one or more doors and outwards through one or more doors.

Series multi-flow (balanced)

A4.10 This is a room as in paragraph A4.9 above, but having either no mechanical ventilation or no net surplus of supply or extract. (for example an anaesthetic room).

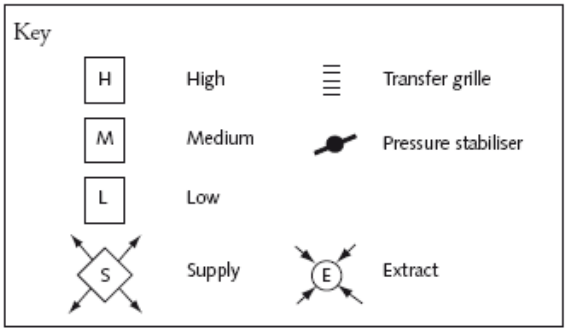
Bay

A4.11 A room which has a permanent opening to the operating room may be considered as a bay off the latter (for example a scrub). Two categories exist:

- open bay – the opening is larger than a normal single door opening. The bay may be considered as part of the main room;
- semi-open bay – the opening is no larger than a normal single door opening. In this case it is possible to protect the bay from the main room by provision of air supply or extract in the bay, or by passing air to or from another area.

Air-movement control in peripheral rooms

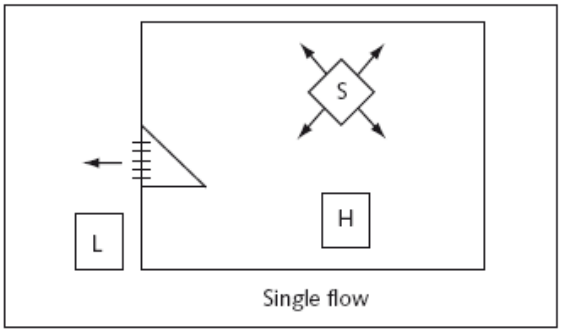
A4.12 For the design of air-movement control, two types of air-transfer device are considered. These are transfer grilles and pressure stabilisers. Each has a particular field of application within the design, as described in paragraphs A4.34 – A4.43. Air movement is controlled in each of the different room types described in paragraphs A4.13 – A4.31.



Note: This key applies to each diagram in 4.13 - 4.27.

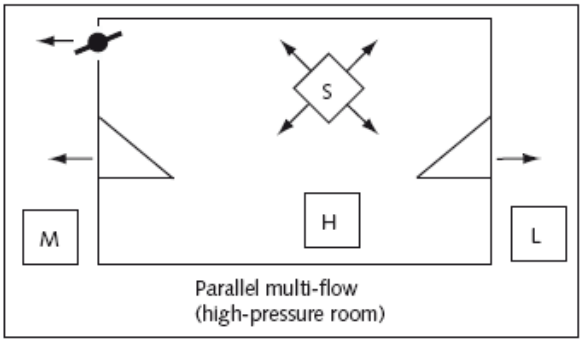
Single flow rooms

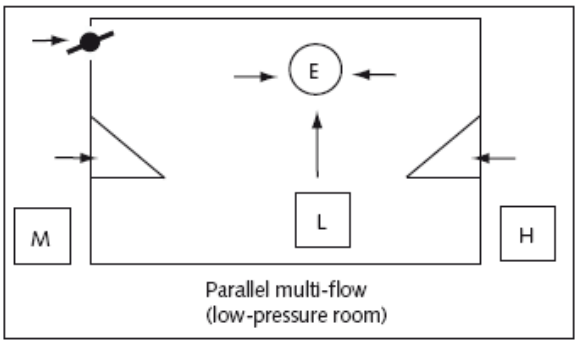
A4.13 An appropriately-sized transfer grille should be located in or adjacent to the door of each single flow room to relieve the pressure differences across the door when closed.



Parallel multi-flow rooms

A4.14 The pressure difference across the closed doors must be relieved, but transfer grilles are not appropriate where two doors lead to areas of different pressures, because reverse flow could occur when the other door is open. For this reason, pressure stabilisers are used.



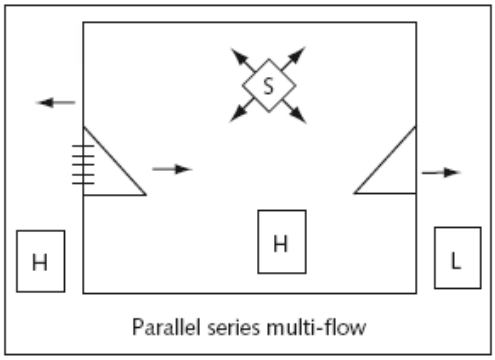


A4.15 These rooms will be either high-pressure or low-pressure with respect to the adjacent areas (see preparation lay-up room and disposal room, respectively, in standard layout 5 of Appendix 3). The pressure-relief damper is always situated between the room and area, which results in the smaller differential pressure to ensure best use of air.

A4.16 Just as reverse flow can occur if transfer grilles are used, it can similarly occur via door gaps when the other door is opened. It is not possible to avoid this, except by using air locks, but due to the low flow rates and short durations involved, this is not considered to be of importance.

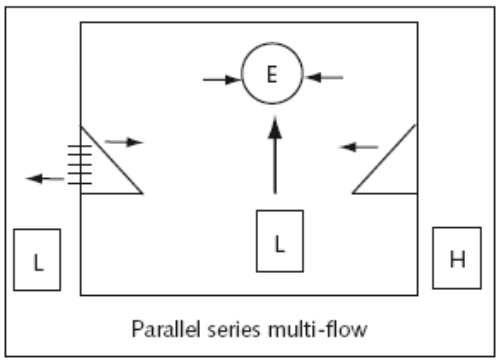
Parallel-series multi-flow rooms

A4.17 These rooms are similar to those in paragraph A4.14 above, but because the room is of equal cleanliness to one of the adjacent rooms the nominal pressures will be equal and air may flow through the adjoining doorway in either direction. (for example the Prep (SPS) in standard layout 6 of Appendix 3).



Parallel series multi-flow

A4.18 Where the nominal room pressure equals that of the higher-pressure adjacent room, the best use of air is by supplying air required for bacterial dilution only and allowing this to exhaust via a transfer grille to the area of equal cleanliness. The doorway to the lower pressure area is protected by the combination of the supply air and the air that will flow inwards through the transfer grille from the area of equal cleanliness.

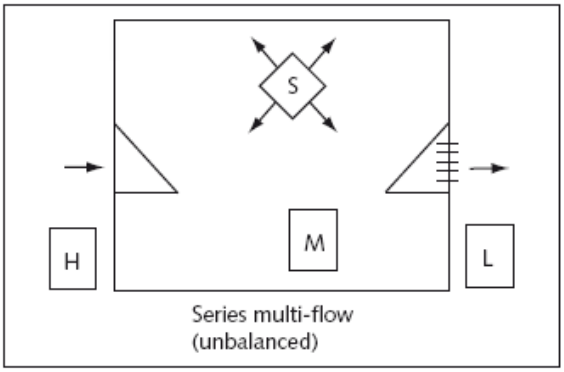


Parallel series multi-flow

A4.19 Conversely, where the nominal pressure equals that of the lower-pressure adjacent room, extract ventilation and a transfer grille to the lower pressure adjacent room should be provided. (for example the disposal room in standard layout 8 of Appendix 3).

Series multi-flow (unbalanced)

A4.20 These rooms are somewhat similar to those in paragraph A4.15 above, but because the pressure lies between that of the rooms on either side, the back-flow problem does not exist.



Series multi-flow (unbalanced)

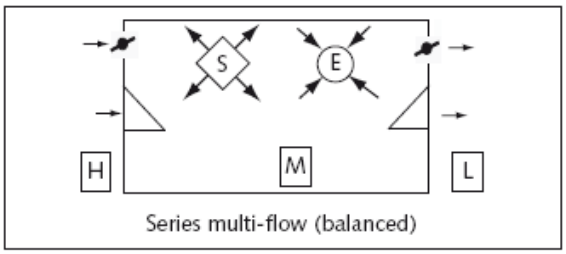
A4.21 Where the room has a net surplus of mechanical supply air, a transfer grille should be located in or adjacent to the door through which air flows outwards, and the mechanical supply flow rate to the room should be chosen to give protection when this door is open.

A4.22 Where the room has a net surplus of mechanical extract air, a transfer grille should be located adjacent to the door through which the air flows inwards, and the mechanical extract flow rate to the room should be chosen to give protection when this door is open.

A4.23 The grille must be sized for the protection requirement of the opposing door when open. When the room on the high-pressure side depressurises, there is a possibility of back-flow through gaps around the door, but this problem may be ignored.

Series multi-flow (balanced)

A4.24 In these rooms, a transfer device adjacent to each doorway is required in order to provide a flow path for the air required to protect the opposing door when opened.



Series multi-flow (balanced)

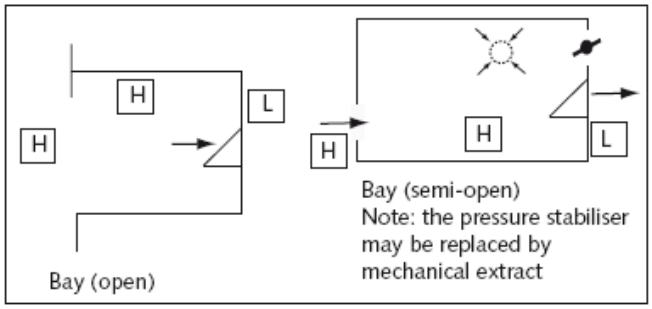
A4.25 These transfer devices will normally be pressure stabilisers, although transfer grilles may be used where a large amount of excess air is to be exhausted from the operating room when all doors are closed. (for example anaesthetic rooms).

A4.26 The calculation procedure is to assume that pressure stabilisers are being used; then (if there is sufficient excess air) change to transfer grilles as described in paragraph A4.50.

Bay

Open bay

A4.27 A bay of the open type (for example scrub-up) is considered to be part of the operating room. Provided air movement is satisfactory, no specific extract is required.



Semi-open bay

A4.28 In a bay of the semi-open type, protection of one area from the other is possible. (for example scrub-up).

A4.29 As stated previously, the need for protection between operating room and scrub-room is not very great. Better use of air can therefore be achieved in this case by installing a pressure stabiliser between the scrub-room and clean corridor. This will allow a flow of air through the scrub-room at all times, except when a door is opened elsewhere in the suite. The pressure stabiliser will then close and the air will be diverted to the other door. When it is considered necessary to protect the scrub-room at all times, either a transfer grille to the corridor or mechanical extract in the scrub-room should be provided.

Operating room

A4.30 Once the peripheral rooms have been considered, the operating room requirements may then be decided and the supply flow rate required for air-movement control calculated. This flow rate should be such that, with any one door open, the correct air movement directions are maintained. There will be one door in the suite that will require the largest supply flow rate to the

operating room for protection when open. This is called the “key door” and is discussed separately in paragraph A4.33. Use of this concept avoids repetitive calculations for each door in turn. Having established the required supply flow rate, a relief route must be provided to the clean corridor for any excess air when the doors are closed. This would be via transfer grilles or pressure stabilisers through a series-flow room or via pressure stabilisers to the clean corridor directly.

Corridors

A4.31 All surplus air from the suite, except that lost through structure leakage and any passing to the outer corridor, will arrive in the patient/staff corridor. Should this air be insufficient to achieve the required air-change rate (see Appendix 2), some additional air supply should be provided. (The air balance should take account of structural leakage.)

Door opening

A4.32 Wheras the resulting pressures are dependent on ductwork layout, room relationships and characteristics of the fan, the generalisations shown in Appendix 2 can be used to estimate the change in room pressure when a door is opened.

A4.33 The “key door” will be the open double door which leaves the operating room at the highest pressure, and/or requires the largest air flow. This should be determined using the procedure in worksheet WS3.

Transfer Grilles

A4.34 These may be used to limit the pressure differences across the closed door of a single-flow room or, in some instances, for protection of a series-flow or parallel-series-flow room. They allow air flow in both directions and may not be suitable for all applications.

A4.35 The free area of a grille is calculated from the following equation:

$$A = \frac{Q}{0.84\sqrt{\Delta P}}$$

where:

A is free area (m^2)

Q is flow rate (m^3/s)

P is pressure difference (Pa).

A4.36 The flow through a grille at a different pressure may be found from the following equation:

$$Q_2 = Q_1\sqrt{\frac{\Delta P_1}{\Delta P_2}}$$

where:

Q_1 and P_1 are original flow and differential pressure

Q_2 and P_2 are new flow and differential pressure.

A4.37 The transfer grille may be replaced by carefully proportioned door undercuts of the equivalent free area.

A4.38 The function of the transfer grille is to provide a means of air-flow control by which the volume and pressure loss can be established. If a grille is used, it should have an easily removable core to facilitate cleaning.

Pressure-relief dampers

A4.39 The functions of a pressure-relief damper are now carried out by pressure stabilisers. Accordingly, all mention of them has been removed from this document.

Pressure stabilisers

A4.40 Pressure stabilisers can be adjusted to hold the pressure constant over a wide range of flow rates. They are used where requirements exist for accurate room-pressure control or rapid shut-off on pressure fall.

A4.41 The installation of a grille or baffle in association with a stabiliser will alter the operating characteristics. It is recommended that a location be chosen to avoid the need for visual screening, for example, at high level. The location should be chosen to minimise the likelihood of damage.

A4.42 The stabilisers used should be virtually silent in operation, adjustable on site, maintenance-free and of a type which cannot be wrongly inserted. They should not be used in external walls or where the pressure difference is less than 5 Pa. The required size of a pressure stabiliser is dependent on the design pressure difference across it and flow rate through it. The manufacturer should provide data relating pressure difference to mean velocity (or flow rate per unit area). From this, the required area can be calculated and then rounded-up to the nearest size manufactured or nearest combination of smaller sizes.

A4.43 It is sometimes possible to arrange for a pressure stabiliser to perform two tasks. In an anaesthetic room, for example, the two pressure stabilisers may be made to pass the open door protection air, and also control the operating and anaesthetic room pressures with the door closed. To achieve this, the stabilisers are sized for the flow rate required with one of the doors open, but the pressure setting is adjusted to be the value required with the doors closed. This is shown in Figure A4/1.

Figure A4/1

Calculation sheet for flow rates			Worksheet WS1 Reference:			
Room name						
1. Summer temperature control Heat gain	kW					
2. Acceptable Δt	°C					
3. Air flow rate (S_G) $= \frac{\text{Gain}}{\Delta t \times 1.2}$	m^3/s					
4. Winter temperature control Heat loss	kW					
5. Acceptable Δt	°C					
6. Air flow rate (S_L) $= \frac{\text{Loss}}{\Delta t \times 1.2}$	m^3/s					
7. Dilution of bacterial contaminants Air flow rate	m^3/s					
S_D or E_D						
8. Desired air change rate	AC/hr					
$\frac{\text{AC/hr} \times \text{room volume } (m^3)}{3600}$	m^3/s					
9. Maximum of S_G, S_L, S_D or E_D or air change rate from step 8	m^3/s					
10. Air movement control Air flow rate for air movement control S_{AMC} or E_{AMC} (from WS2, WS3 or WS4)	S m^3/s					
	E m^3/s					
11. Final supply flow rate (S_F)	m^3/s					
12. Final extract	m^3/s					
13. Total supply		m^3/s				
14. Total extract		m^3/s				

Surveyor (AP(V)/CP(V)) ..... Date .....

Door leakage flows

A4.44 For an air-movement control scheme to work satisfactorily, it is essential that the estimates of door-gap leakage made at the design stage are closely related to those which are achieved in practice. The calculation of gap-flows generally fall into the transition region between laminar and turbulent flow and hence do not follow the normal flow equations. The gaps assumed are 4mm along the bottom, 3mm at the top and sides, and 2mm between double leaves. Doors should not have wider gaps than these. Tighter gaps would result in lower flow-rate requirements and hence lower fan power, but care should be taken to ensure that all doors in the suite have similar gap dimensions. It may be

possible to ignore the door leakage and so reduce the air-flow requirement (see the notes in Appendix 3).

Room temperature estimation

A4.45 The air-flow rate required to prevent back-flow through an open door is dependent on the temperature difference across the door. The design figures shown in Appendix 3 are based on the temperature differences that will normally occur in practice, assuming heat gains and losses in accordance with Appendix 3.

A4.46 At step 11 of the air-flow design process, the temperature differences across the doors of all rooms classed as “sterile” are calculated. Worksheet WS6 is recommended for the calculations, using the following criteria:

- assume that the operating room is being controlled at 20°C and calculate the incoming air-supply temperature as shown on worksheet WS6;
- the calculation should be repeated for both summer and winter conditions, with an operation in progress;
- assume all doors are closed;
- use the room supply flow rates from WS1;
- use the inward air flows through air-transfer devices and closed door leakages from WS2a to WS2e;
- the formula used in worksheet WS6 is as follows:

$$T = \frac{(t_1Q_1 + t_2Q_2 + \cdots + t_nQ_n) + 0.828H}{(Q_1 + Q_2 + \cdots Q_n)}$$

where:

Q = flow rate from source (m^3/s)

t = the temperature of source (°C)

H = the room heat gain (kW).

A4.47 If the evaluated temperature differences between rooms do not exceed 2°C, the solution is satisfactory; otherwise proceed as follows:

i. check the assumption on which the heat gains are based;
ii. take steps to reduce the heat gains;
iii. if the door is to a corridor, the flow through the open door will be larger than the value given in Appendix 3. Calculate on WS3, assuming it is the “key door” with door-flow unknown, and the supply as known;
iv. if the door leads to a room with mechanical supply, install a trimmer heater in the supply to the room controlled by either a differential thermostat or a

thermostat slaved to the operating room thermostat to ensure that *T* is minimized.

v. If the door leads to a room with no mechanical supply, increase the door protection flow as follows:

$$Q_{new} = Q_{old}\left[\frac{\Delta T + 1}{2}\right]$$

A4.48 These options should be considered in this order, and (i), (ii) and (iii) should be investigated thoroughly before proceeding to (iv) or (v). The mechanical supply may need to be increased in order to achieve the desired air-change rates.

Relief of excess air from operating room when all doors are closed

A4.49 As the mechanical supply to the operating room is sized to provide an appropriate flow outward through any door which is opened, it follows that when all doors are closed, there will be more air supplied to the operating room than can exit from it via leaks etc. This "excess" air can be relieved by either of the two methods described in paragraphs A4.50 - 4.54.

By transfer devices via the anaesthetic room

A4.50 For door protection, the transfer devices in the anaesthetic room are typically designed to pass 0.47 m^3/s at a differential pressure of 14 Pa. When the doors are closed, the differential pressure will change to 11 Pa between theatre and anaesthetic room, and 14 Pa between anaesthetic room and corridor; the volume of air passed by the transfer devices will be modified as shown in the following formula:

$$Q = Q_1\left(\frac{\Delta P_1}{\Delta P_2}\right)^{1/2}$$

$$= 0.47\left(\frac{11}{14}\right)^{1/2}$$

$$= 0.42\ m^3/s$$

where:

Q = "excess" air to be vented with doors closed;

Q_1 = air flow required for door protection through transfer device;

ΔP_1 = nominal differential pressure with door to operating room closed and door to corridor closed;

ΔP_2 = nominal differential pressure between either the anaesthetic room and corridor when the operating room door is open, or the anaesthetic room and

operating room when the corridor is open. This differential pressure is used when selecting size of both devices.

A4.51 If the "excess" air is less than 0.42 m^3/s, a pressure stabiliser is required to ensure that the correct protection air-flow is available to pass through the door.

A4.52 If the "excess" air is greater than 0.42 m^3/s, a transfer grille is acceptable because at all times the air-flow will exceed the flow required for door protection.

By pressure stabilisers to the corridor

A4.53 If it is undesirable to pass operating room air through the anaesthetic room, it may be passed directly to a corridor via a separate pressure stabiliser.

A4.54 If there is sufficient "excess" air, the transfer grille solution at paragraph A4.52 should be adopted, as it provides the simplest solution and, once set up, will require no further maintenance. With less excess air, it is recommended that the air be passed through the anaesthetic room via the pressure stabilisers as at paragraph A4.51, thus keeping the number of pressure stabilisers to a minimum. Both these solutions increase the air-change rate in the anaesthetic room, but care should be taken to avoid passing excessive amounts through that would cause discomfort to the occupants.

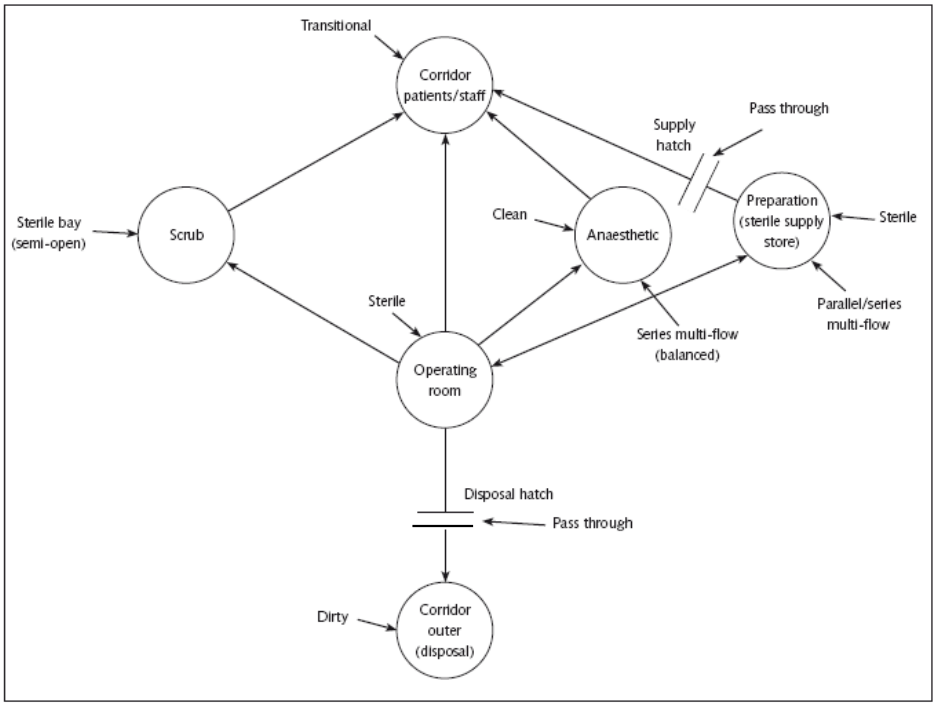


Figure A4/2. An example of an air-flow network

Step	Description	Worksheet
1	Show nominal room pressures and air flow directions on the plan of the theatre suite and WS1	WS1
2	Enter heat/loss/gain data and calculate supply air flow rates for temperature control only. Categorise room types, eg sterile, clean etc	WS1
3	Enter air flows required for bacterial contamination control or air change rate, whichever is the greater; add supply and extract volumes (S_D, E_D) on the plan	WS1
4	Define peripheral room types, see paragraphs A8.5–A8.11, and select appropriate worksheets	Select from WS2a to WS2e
5	Locate air transfer devices, enter details on worksheets and locate on the plan and Figure A2	Selected worksheets from WS2a to WS2e
6	For each peripheral room, determine air flows through doors when open and calculate mechanical supply or extract and transfer device flows	as above
7	Select "Key Door" and calculate air supply for operating room	WS3
	Does this door produce solution with greatest flow? — NO → (return to step 7)	
	YES ↓	
8	Transfer to WS1 and select final rate S_F and E_F	WS1, WS3
9	Make provision for relief of excess air with doors closed	Selected worksheets and WS3
10	Calculate supply and extract flow rates for corridor(s)	WS4, WS5
11	Calculate room temperatures (all doors closed) and ΔTs	WS6a and WS6b
	Do any ΔTs across doors to sterile rooms exceed 1.0°C? — YES → Rectify as in paragraph A8.47	
	NO ↓	
12	Make summary of flows	WS6a and WS6b
13	Size transfer devices, size ductwork, central plant etc	WS7
14	Design ductwork layout, control plant etc	–

Figure A4/3 Air-flow design procedures

Calculation sheet for flow rates			Worksheet WS1 Reference:			
Room name						
1. Summer temperature control Heat gain	kW					
2. Acceptable Δt	°C					
3. Air flow rate (S_G) $= \frac{\text{Gain}}{\Delta t \times 1.2}$	m^3/s					
4. Winter temperature control Heat loss	kW					
5. Acceptable Δt	°C					
6. Air flow rate (S_L) $= \frac{\text{Loss}}{\Delta t \times 1.2}$	m^3/s					
7. Dilution of bacterial contaminants Air flow rate	m^3/s					
S_D or E_D						
8. Desired air change rate	AC/hr					
$\frac{\text{AC/hr} \times \text{room volume } (m^3)}{3600}$	m^3/s					
9. Maximum of S_G, S_L, S_D or E_D or air change rate from step 8	m^3/s					
10. Air movement control Air flow rate for air movement control S_{AMC} or E_{AMC} (from WS2, WS3 or WS4)	S m^3/s					
	E m^3/s					
11. Final supply flow rate (S_F)	m^3/s					
12. Final extract	m^3/s					
13. Total supply		m^3/s				
14. Total extract		m^3/s				

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Air movement control **Peripheral room ..... type, single flow**			**Worksheet WS2a** **Reference:**		
			Nominal pressure:		**Pa**
Consider door to ..... open					
			Air flow, m^3/s		
	Pa	Δt	Out	In	Remarks
Flow required through doorway to give protection					
Total					
S_{AMC} $(\Sigma_{OUT} - \Sigma_{IN})$ ☐ m^3/s or E_{AMC} $(\Sigma_{IN} - \Sigma_{OUT})$ ☐ m^3/s Transfer S_{AMC} or E_{AMC} to WS1					
Consider door to ..... closed					
	Pa	Δt	Out	In	Remarks
Closed door leakage					
Total					
Return S_F and E_F to WS1 ☐ ☐ Flow through transfer grille outward $(S_F - E_F - L_{OUT})$ ☐ or Flow through transfer grille inward $(E_F - S_F - L_{IN})$ ☐					

Surveyor (AP(V)/CP(V)) ..... Date .....

Air movement control **Peripheral room ..... type, parallel/series multi-flow**	**Worksheet WS2b** **Reference:** **Nominal pressure:** **Pa**

Door from this room to ..... (room of equal cleanliness) is not to be protected.
A transfer grille is located in, or adjacent to, this door

Consider other door to ..... open.

Room pressure now becomes [ ] or [ ] or [ ] Pa (see Appendix 6)

			Air flow, m^3/s		
			Out	In	Remarks
Flow required through doorway to give protection					
At above pressures leaks through closed doors	Pa	ΔP			
Mechanical supply or extract (S_F/E_F)					
		Total			

X ($\Sigma_{OUT} - \Sigma_{IN}$) [ ] or Y ($\Sigma_{IN} - \Sigma_{OUT}$) [ ]

Transfer grille required
from high-pressure zone Flow = X
or [ ] at [ ] ΔPa
to low-pressure zone Flow = Y

Size of transfer grille (free area) A1 [ ]

Consider doors and hatch closed – room presssure becomes [ ] Pa (nominal)

Closed door leakage from Appendix 4 (assuming no transfer grille)	Pa	ΔP	Out	In	Remarks
Mechanical supply or extract					
		Total			

Air flow required through transfer grille = IN – OUT = Z' [ ]

or OUT – IN = Z'' [ ]

Transfer grille required flow Z' or Z'' [ ] @ [ ] ΔP

Size of transfer grille (free area) A2 = [ ]

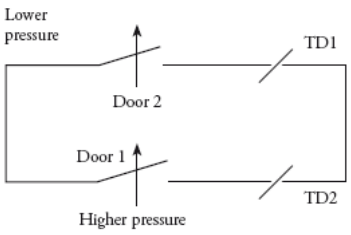
Select larger of A1 or A2 [ ]

Surveyor (AP(V)/CP(V)) ..... Date .....

Air movement control **Peripheral room ..... type, parallel multi-flow high/low or series multi-flow (unbalanced)**			**Worksheet WS2c** **Reference:** **Nominal pressure:** **Pa**		
Consider door from this room to ..... open. Room pressure now becomes [ ] or [ ] or [ ] Pa (see Appendix 6)					
			Air flow, m^3/s		
			Out	In	Remarks
Flow required through open doorway to give protection					
At above pressures leaks through closed doors are:	Pa	ΔP			
		Total			
S_1 ($\Sigma_{OUT} - \Sigma_{IN}$) [ ] or E_1 ($\Sigma_{IN} - \Sigma_{OUT}$) [ ]					
Consider door from this room to ..... open. Room pressure now becomes [ ] or [ ] or [ ] Pa					
			Out	In	Remarks
Flow required through open doorway to give protection					
At above pressures leaks through closed doors are:	Pa	ΔP			
		Total			
S_2 ($\Sigma_{OUT} - \Sigma_{IN}$) [ ] or E_2 ($\Sigma_{IN} - \Sigma_{OUT}$) [ ]					
Consider doors closed. Closed doors leakage from Appendix 4					
Door to:	Pa	ΔP	Out	In	Remarks
		Total			
Return S_F and E_F from WS1 [ ] Flow through transfer device outward ($S_F - L_{OUT}$) [ ] to ..... or Flow through transfer device inward ($E_F - L_{IN}$) [ ] from ..... Transfer grille [ ] Pressure relief damper [ ]					

Surveyor (AP(V)/CP(V)) ..... Date .....

Air movement control **Peripheral room ..... type, series multi-flow (balanced)**			**Worksheet WS2d** **Reference:** **Nominal pressure:** Pa		
Note: In this type of room the supply and extract air flow rates are equal and take no part in the air movement control (AMC)					
First, open door to higher pressure area. Room pressure then becomes [ ] or [ ] or [ ] Pa (see Appendix 6)					
			Air flow, m^3/s		
			Out	In	Remarks
Flow required through open doorway to give protection. See Appendix 6					
At above pressures leaks through closed doors are:	Pa	ΔP			
Total					
Q_1 ($\Sigma_{IN} - \Sigma_{OUT}$) [ ] (+ve inwards)					
Next, open door to lower pressure area. Room pressure then becomes [ ] or [ ] or [ ] Pa					
			Out	In	Remarks
Flow required through open doorway to give protection					
At above pressures leaks through closed doors are:	Pa	ΔP			
Total					
Q_2 ($\Sigma_{OUT} - \Sigma_{IN}$) (+ve outwards)					
Flow through transfer device (TD1) to protect door 1 = $Q1$ [ ] at resultant ΔP ..... Flow through transfer device (TD2) to protect door 2 = $Q2$ [ ] at resultant ΔP					



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Air movement control **Peripheral room ..... type bay (semi-open)**			**Worksheet WS2e** **Reference:** **Nominal pressure:** **Pa**		
Note: If the room is of the open bay type (ie opening is larger than normal single doorway), the room should be considered part of the main room. No air movement control considerations need then be made, and this sheet can be discarded. Supply and/or extract flow will be based on air distribution considerations.					
Consider permanent opening					
			Air flow, m^3/s		
			Out	In	Remarks
Flow required through opening to give protection					
Leaks through closed doors to:	Pa	ΔP			
		Total			
E_{AMC} [ ] or flow outward through transfer device ($\Sigma_{IN} - \Sigma_{OUT}$) [ ]					
Transfer S_{AMC} or E_{AMC} to WS1					
Transfer device – transfer grille [ ] – pressure stabiliser [ ]					
Size select transfer device for flow rate [ ] @ ΔP [ ]					
Note: A door from the bay is considered with the peripheral room to which it leads or, if it leads to the corridor, it is considered with the main room					

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Air movement control **Operating room**			**Worksheet WS3** **Reference:**		
			Nominal pressure: Pa		
Note: To avoid considering each door open in turn, the "key door" concept is introduced. This is the door which requires the greatest mechanical flow when open. See paragraph A8.33					
Select "key door" (see above). Consider this door open – room pressure now becomes ☐ Pa (see Appendix 6) See Appendix 7 for room pressures					
			Air flow, m^3/s		
			Out	In	Remarks
Flow required through doorway to give protection					
Air flow "out" or "in" via doors, transfer devices etc	Pa	ΔP			
Mechanical extract					
Total					
S_{AMC} ($\sum_{OUT} - \sum_{IN}$) ☐ transfer S_{AMC} to WS1					
Consider all doors closed. Return S_F from WS1 ☐ Room pressure now ☐ Pa (nominal)					
Air flow "out" or "in" via door leakage, transfer devices etc	Pa	ΔP	Out	In	Remarks
Mechanical extract and supply					
Total					
Flow ($\sum_{IN} - \sum_{OUT}$) through transfer device ☐ @ ΔP ☐ to ..... For final selection of transfer device see paragraphs A8.50–A8.54					

Surveyor (AP(V)/CP(V)) ..... Date .....

Air movement control **Corridor**			**Worksheet WS4** **Reference:**		
			Nominal pressure:		**Pa**
Consider all doors closed					
			Air flow, m^3/s		
			Out	In	Remarks
Flow required through doorway to give protection					
Leaks through closed doors, transfer devices, permanent openings etc	Pa	ΔP			
Total flow inwards (S_1)					
Add mechanical input (S_2) if necessary to increase S_1 to give 7 AC/hr					
Total flow outwards and inwards					
$S_{AMC} = (\Sigma_{OUT} - \Sigma_{IN} + S_2)$ [ ] Transfer to WS5					
or $E_{AMC} = (\Sigma_{IN} - \Sigma_{OUT} + S_2)$ [ ] Transfer to WS5					

Note: this sheet to be used for each individual operating theatre suite (or pair of suites if they share a preparation room)

Surveyor (AP(V)/CP(V)) ..... Date .....

Air movement control	**Worksheet WS5** **Reference**	
Summary of air supply and extract for an operating suite		
Air flow to corridor	All doors closed	Anaesthetic (key door open)
	m^3/s	m^3/s
From preparation		
From operating room		
From scrub		
From anaesthetic		
Total (a)		
Air flow to corridor From disposal		
From other source		
Total (b)		
Other room supplies ..... Total (c)		
Total air supply (a) + (b) + (c)		
Consider corridor ventilation (see Appendix 3) and calculate air volume required, based on 7 AC/hr (see Note 1)		
		m^3/s
Air flow required to ventilate corridor		
Air flow required to ventilate service corridor (see Note 2)		
If the air flow from the operating suite (a) and (b) is greater than the calculated required volume, no further supply air is necessary		
		m^3/s
Additional air to ventilate corridor		
Additional air to ventilate service corridor (see Note 2)		
Air extract The size of the extract plant should be of the order of 10% below the supply to assist in maintaining the department under positive pressure relative to the outside departments		
		m^3/s
Extract plant = Supply less leakage		
Less 10% of supply		
Total extract (see Note 3)		

Notes: 1. In the case of a multi-theatre operating department, the air balance for the corridor should be considered as a separate exercise, taking into account the final dispersal of excess air.
2. Omit these if only one corridor in operating suite.
3. The extract volume includes 0.24 m^3/s from the anaesthetic room for a balanced condition

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Room temperature – summer	**Worksheet WS6a** **Reference:**

Find summer supply temperature $T_{SS} = 20 - \dfrac{0.828H(O/R)}{Q(O/R)}$ = T_{SS} ____ °C

Note: the temperature of a space may be calculated from

$$T = \frac{t_1Q_1 + t_2Q_2 + \ldots\ldots\ldots + t_nQ_n + (0.828H)}{Q_1 + Q_2 + \ldots Q_n}$$

Where t_1 is temperature of source 1 (°C)
Q_1 is flow from source 1 when all doors are closed (m^3/s)
H is heat gain in space (kW)

Room	Heat gain kWh	Supply		Flows inwards										Temperature °C T
		Q	T_{SS}	From		From		From		From		From		
				Q	t	Q	t	Q	t	Q	t	Q	t	

Check doors to sterile areas

Door between	Calculated room ΔT (°C)	Maximum ΔT permitted	Remarks

Surveyor (AP(V)/CP(V)) ..... Date .....

Room temperature – winter	**Worksheet WS6b** **Reference:**

Find winter supply temperature $T_{SW} = 20 - \dfrac{0.828H(\text{O/R})}{Q(\text{O/R})}$ = T_{SW} ____ °C

Note: the temperature of a space may be calculated from

$$T = \frac{t_1Q_1 + t_2Q_2 + \ldots\ldots\ldots + t_nQ_n + (0.828H)}{Q_1 + Q_2 + \ldots Q_n}$$

Where t_1 is temperature of source 1 (°C)
Q_1 is flow from source 1 when all doors are closed (m^3/s)
H is heat gain in space (kW)

Room	Heat gain kWh	Supply		Flows inwards										Temperature °C T
		Q	T_{SW}	From		From		From		From		From		
				Q	t	Q	t	Q	t	Q	t	Q	t	

Check doors to sterile areas

Door between	Calculated room ΔT (°C)	Maximum ΔT permitted	Remarks

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Transfer grilles, pressure relief dampers and pressure stabilisers							**Worksheet WS7** **Reference:**
Transfer grilles – see paragraphs A8.34–A8.38							
No	Location	Pressure difference Pa	Flow rate m^3/s	Free area m^2	Model	Resultant Δp Pa	Remarks
Pressure relief dampers – see paragraph A8.39							
No	Location	Pressure difference Pa	Flow rate m^3/s	Free area m^2	Pressure setting Pa	Remarks	
Pressure stabilisers – see paragraphs A8.40–A8.43 Note: where a stabiliser is acting both as series room door protection and operating pressure control, "pressure difference" and "flow rate" are from WS2d; "pressure setting" is from WS3							
No	Location	Pressure difference Pa	Flow rate m^3/s	Free area m^2	Pressure setting Pa	Remarks	

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References

Acts and regulations

Scottish Technical Handbooks Non Domestic. Scottish Building Standards Agency, 2007. http://sbsa.gov.uk

Scottish Technical Handbooks, Non Domestic, Section 2: Fire. Scottish Building Standards Agency. 2007 http://sbsa.gov.uk

Scottish Technical Handbooks, Non Domestic Section 6: Energy. Scottish Building Standards Agency 2007. http://sbsa.gov.uk

Control of Substances Hazardous to Health Regulations (COSHH) 2002. SI 2002 No 2677. TSO, 2002. www.opsi.gov.uk/si/si2002/20022677.htm

Health Act 2006. TSO, 2006. www.opsi.gov.uk/ACTS/acts2006/20060028.htm

Health and Safety at Work etc Act 1974. HMSO, 1974.

Management of Health and Safety at Work Regulations 1999. SI 1999 No 3242. TSO, 1999. www.opsi.gov.uk/SI/si1999/19993242.htm

Medicines Act 1968. TSO, 1968.

Provision and Use of Work Equipment Regulations 1998. SI 1998 No 2306. HMSO, 1998. www.opsi.gov.uk/SI/si1998/19982306.htm

Workplace (Health, Safety and Welfare) Regulations 1992. SI 1992 No 3004. HMSO, 1992. www.opsi.gov.uk/si/si1992/Uksi_19923004_en_1.htm

British Standards

BS 5588-9:1999. Fire precautions in the design, construction and use of buildings. Code of practice for ventilation and air conditioning ductwork. British Standards Institution, 1999.

BS 5726:2005. Microbiological safety cabinets. Information to be supplied by the purchaser to the vendor and to the installer, and siting and use of cabinets. Recommendations and guidance.

BS 5925:1991. Code of practice for ventilation principles and designing for natural ventilation.

BS EN 779:2002. Particulate air filters for general ventilation. Determination of the filtration performance.

BS EN 1822-1:1998. High efficiency air filters (HEPA and ULPA). Classification, performance testing, marking.

BS EN 1822-2:1998. High efficiency air filters (HEPA and ULPA). Aerosol production, measuring equipment, particle counting statistics.

BS EN 1822-3:1998. High efficiency air filters (HEPA and ULPA). Testing flat sheet filter media.

BS EN 1822-4:2000. High efficiency air filters (HEPA and ULPA). Determining leakage of filter element (scan method).

BS EN 1822-5:2000. High efficiency air filters (HEPA and ULPA). Determining the efficiency of filter element.

BS EN 12469:2000. Biotechnology. Performance criteria for microbiological safety cabinets.

BS EN 13030:2001. Ventilation for buildings. Terminals. Performance testing of louvers subjected to simulated rain.

BS EN 14175-2:2003. Fume cupboards. Safety and performance requirements.

BS EN ISO 14644-1:1999. Cleanrooms and associated controlled environments. Classification of air cleanliness.

BS EN ISO 14644-4:2001. Cleanrooms and associated controlled environments. Design, construction and start-up.

Department of Health Publications

(The) Health Act 2006: Code of practice for the prevention and control of healthcare associated infections. 2006. www.dh.gov.uk

Health Building Nore 26 – Facilities for surgical procedures. The Stationery Office, 2004.

Health Technical Memorandum 55 – Windows. The stationery Office, 1998.

Health Technical Memorandum 58 – Internal doorsets. The Stationery Office, 2005.

Health Technical Memorandum 05-02 – Guidance in support of functional provisions for healthcare premises. The Stationery Office, 2007.

Model Engineering Specification C04 – Mechanical ventilation and air conditioning systems. The Stationery Office, 1997.

NHSScotland Publications

Scottish Health Planning Note 13: Sterile services department. Health Facilities Scotland forthcoming.

Scottish Health Technical Memorandum 04-01 – The control of *Legionella*, hygiene, 'safe' hot water, cold water and drinking water systems. Health facilities Scotland 2009.

Scottish Health Technical Memorandum 81: Fire Preventions in New Hospitals, 2003. Health Facilities Scotland .

Scottish Health Technical Memorandum 07-01: Safe management of healthcare waste. Health Facilities Scotland forthcoming.

Scottish Health Technical Memorandum 08-01: Acoustics. Health Facilities Scotland forthcoming.

Scottish Health Facilities Note 30: Infection Control in The Built Environment: Design and planning. Health Facilities Scotland 2007.

Chartered Institution of Building Services publications

Applications Manual AM10 – Natural ventilation in non-domestic buildings. CIBSE, 2005.

Applications Manual AM13 – Mixed mode ventilation. CIBSE, 2000.

Commissioning Code A: Air distribution systems. CIBSE 1996.

Commissioning Code R: Refrigerating systems. CIBSE 2002.

Commissioning Code W: Water distribution systems. CIBSE 2003.

Guide A: Environmental design. CIBSE, 2006.

Guide B: Heating, ventilating, air conditioning and refrigeration. CIBSE, 2005.

Lighting guide LG2: Hospitals and health care buildings. CIBSE, 1989.

Heating & Ventilating Contractors' Association (HVCA) publications

DW/143 – A pratical guide to ductwork leakage testing. HVCA Publications, 1998.

DW/144 – Specification for sheet metal ductwork, low, medium & high pressure/velocity air systems. HVCA Publications, 1998.

DW/154 – Specification for plastics ductwork. HVCA Publications, 2000.

TR/19 – Guide to good practice: internal cleanliness of ventilation systems. HVCA Publications, 2005.

Other publications

Advisory committee on Dangerous Pathogens (2001). **The management, design and operation of microbiological containment laboratories.** HSE Books, 2001.

Building Services Research & Information Association (BSRIA). **Application Guide AG 3/89.3 – Commissioning of air systems in buildings.** BSRIA, 2001.

Building Services Research & Information Association (BSRIA). **COMPAK 1 – Commissioning guides set.**

DIN 1946-4. Ventilation and air conditioning – ventilation in hospitals. Deutsches Institut Fur Normung, 1999.

Health & Safety Commission (2000). **Approved Code of Practice, Legionnaires' disease: the control of legionella bacteria in water systems (L8).** Health and Safety Executive, 2000.

Health & Safety Executive (1993). **HS(G)37: an introduction to local exhaust ventilation.** HSE Books, 1993.

Health & Safety Executive (2005). **Workplace exposure limits: containing the list of workplace exposure limits for use with the Control of Substances Hazardous to Health Regulations 2002 (as amended).** HSE Books, 2005.

Health & Safety Commission's Health Services Advisory Committee (2003). **Safe working and the prevention of infection in clinical laboratories and similar facilities.** HSE Books, 2003.

Health & Safety Commission's Health Services Advisory Committee (2003). **Safe working and the prevention of infection in the mortuary and post-mortem room.** HSE Books, 2003.

Hospital Infection Society (2005). **Microbiological commissioning and monitoring of operating theatre suites.** HIS, 2005. www.his.org.uk/_db/_documents/OTIC-final.pdf

Medicines and Healthcare products Regulatory Agency (2007). **Rules and guidance for pharmaceutical manufacturers and distributors** (The Orange Guide). Pharmaceutical Press, 2007. www.mhra.gov.uk

Water Regulations Advisory Scheme (WRAS) (2005). **Water Fittings and Materials Directory.** WRAS, 2005. www.wras.co.uk

Whyte W, Lidwell OM, Lowbury EJL and Blowers R (1983), Suggested bacteriological standards for air in ultraclean operating rooms. *J Hosp Infect,* Vol 4, pp 133-139.

Whyte W, Shaw BH and Freeman MAR (1974), An evaluation of a partial-walled laminar-flow operating room. *J Hyg Camb*, Vol 73, pp 61-75.

NHS National Services Scotland

In-patient care
Scottish Health Planning Note 04-01:

Adult in-patient facilities

Health Facilities Scotland
Property and Capital Planning

October 2010

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Contents

Preface

About Scottish Health Planning Notes

Scottish Health Planning Notes (SHPNs) give best practice guidance on the design and planning of new healthcare buildings and can also be used on the adaption/extension of existing facilities.

They provide information to support the briefing and design processes for individual projects in the NHSScotland building programme.

This document has been updated by Health Facilities Scotland (HFS) using the core text provided by the Estates and Facilities Division of the Department of Health (DH), England.

Aims and objectives

The document is aimed at a broad audience and covers the subject from its clinical and operational roots through to the design and equipping of accommodation for adult in-patient facilities.

The key role is to advise on the built environment required to implement the planning, construction, commissioning and operation of a new or upgraded facility.

This document also aims to employ innovation in the built environment, advancing the modernisation of diagnosis and treatment, and raising the quality of service in order to provide an environment that is genuinely sympathetic to the needs of all users and recognise the broad range of activities present and their significance.

Other resources in the Health Facilities Scotland knowledge series

Scottish Health Technical Memoranda

Scottish Health Technical Memoranda (SHTMs) give comprehensive advice and guidance on the design, installation and operation of specialised building and engineering technology used in the delivery of healthcare. For example medical gas pipeline systems, ventilation systems, acoustics etc.

SHTMs are applicable to new and existing sites, and are for use at various stages during the inception, design, construction, refurbishment and maintenance of healthcare facilities.

All SHPNs (and HBNs where there are no equivalent SHPNs) should be read in conjunction with the relevant parts of the SHTM series.

Scottish Health Technical Memorandum Building Component series

All SHPNs refer to SHTM Building Component documents for specifications and design guidance on building components for healthcare buildings. All SHPNs should therefore be read in conjunction with the relevant parts of the SHTM Building Component series.

Activity DataBase (ADB)

The Activity DataBase (ADB) data and software assists project teams with the briefing and design of the healthcare environment. The use of ADB is mandatory for all NHSScotland bodies when procuring both new build and refurbishment projects [HDL (2006) 58]. ADB data is based on guidance given in the HBNs, HTMs and HTM Building Component series but are generally compatible with Scottish equivalent guidance documents.

- room data sheets provide an activity-based approach to building design and include data on personnel, planning relationships, environmental considerations, design character, space requirements and graphical layouts;
- schedules of equipment/components are included for each room, which may be grouped into ergonomically arranged assemblies;
- schedules of equipment can also be obtained at department and project level;
- fully loaded drawings may be produced from the database;
- reference data is supplied with ADB that may be adapted and modified to suit the users' project-specific needs.

For further information please refer to the following DH website: www.adb.dh.gov.uk.

How to obtain publications

To find out about new finalised publications, and also older existing guidance, look on the Space for Health website (www.spaceforhealth.nhs.uk) which should be fully operational in 2010.

To access Scottish guidance click on the 'Scotland' tab at the top of the page or click on 'Scotland' on the small map of the UK at the top left of the page.

Board Project Teams and healthcare facility design teams should always check the Space for Health website to ensure that they are using the most up-to-date guidance documents.

Significant changes since the previous edition of this guidance

Scottish Health Planning Note (SHPN) 04 'In-patient accommodation: Options for choice' (2000) provided an evidence-based approach to the planning of facilities, which was based on providing a minimum of 50% single-bed rooms. Further evidence has been gathered on the benefits of single-bed rooms and ergonomic studies have established how much space is needed around the hospital bed for various tasks. The results have shown that the provision of a minimum clear space around the bed is essential in achieving an efficient and effective environment. The Department of Health report on the research by NHS Estates is entitled 'Ward layouts with single rooms and space for flexibility' (DH, 2005).

The Scottish Government announced in CEL 48 (2008) that for all new build hospitals or other healthcare facilities which will provide in-patient accommodation there should be a presumption that all patients will be accommodated in single-bed rooms, unless there are agreed clinical reasons for multi-bed rooms to be available.

Following this an Expert Consultation took place in which the Speciality Advisors considered for which of the specialities 100% provision is appropriate. On conclusion of the expert consultation, the Scottish Government issued CEL 27 (2010) stating that the Chief Medical Officer had concluded that the guidance set out in CEL 48 (2008), that there should be a presumption of 100% single rooms in future hospital developments, is confirmed as the policy for NHSScotland except for:

- *"existing accommodation which is being refurbished, where taking into account the constraints of the existing building, a minimum of 50% single room accommodation would be allowed but as close to 100% as possible would be expected; and*
- *in new developments where there are clinical reasons for not making 100% single room provision they should be clearly identified and articulated in the appropriate Business Case. However, each case would be subject to Scottish Government agreement as part of the Business Case approval process."*

In addition, studies have been carried out to determine efficient space layouts for an en-suite shower room for a single-bed room that meets the needs of the majority of patients. The study resulted in two new layouts for an en-suite shower room, both of which are referred to in this guidance and HBN 00-02: 'Sanitary spaces'.

In 2001 a review of the Department Cost Allowance Guides (DCAGs) concluded that an additional 2.5m^2 per bed should be added to the schedules of accommodation for single-bed rooms and multi bedded rooms.

Since SHPN 04 was published in 2000 the following changes have been made:

- total single-bed rooms - the size of the total single-bed rooms has increased from 21m^2 to 23.5m^2 as a result of the review of DH DCAGs, which added 2.5m^2 to each bed space;
- total four-bed rooms - the size of these rooms has increased from 60m^2 to 72.5m^2 as a result of the reviews which have added 2.5m^2 to each bed space;
- the impact of the Disability Discrimination Act (to be replaced by the Equality Act late 2010), which requires that sanitary facilities should be provided for independent users and those requiring assistance from staff. As a result the assisted shower room, which now includes a WC as well as a shower and wash-hand basin, has increased in area from 4.5m^2 to 6.5m^2. This has increased the overall dimensions of the multi-bed room;
- space increase around the bed - the minimum recommended clear space (see paragraph 2.12) around the bed is now 3.6m wide × 3.7m deep. This can be achieved within the new space allowances for single-bed rooms and four-bed rooms;
- en-suite sanitary facilities for single-bed rooms - the recommended new en-suite shower room layouts for a single-bed room are the same dimensions as in previous guidance but they are more flexible in terms of use and accessibility. They are suitable for ambulant and semi-ambulant patients, the majority of independent wheelchair users, and patients requiring assistance from staff (see HBN 00-02: ‘Sanitary spaces’);
- isolation suites – single-bed rooms provide effective isolation for many patients. In some cases however, a greater degree of isolation may be required. SHPN 04 Supplement 1: ‘Isolation facilities in acute settings’ gives detailed guidance on isolation suites (bedroom, en-suite sanitary facilities, and lobby);
- dirty utility rooms - ideally, a dirty utility room should serve no more than 15 beds. This reduces travel distances for staff, making better use of nursing time and reducing the risk of spillage and cross-contamination. A second dirty utility room on a ward is also helpful during outbreaks of illness or infectious diseases. Where there is 100% single-bed room provision and the staff support zone is in a central position a single-bed room may be acceptable as there may be less requirement for the use of bedpans. Dirty utility rooms in previous guidance served 24 to 30 beds. For more information on utility rooms see HBN 00-03:’Clinical and clinical support rooms’;
- schedules of accommodation - the previous SHPN was based on a modular approach to planning and the schedules of accommodation were presented in modules for eight-bed clusters. This new guidance is based on 24 beds, which provides a typical example of an average-sized ward. Where smaller or larger wards are required, design teams can adapt the guidance to suit local clinical need.

Summaries of changes in space requirements

Area	SHPN 04 2000 (m^2)	Schedules of Accommodation 2003 (m^2)	Difference (m^2)	SHPN 04-01 2009 (m^2)	Difference (m^2)
Single-bed room	13.5	16.0		19.0	
Family and clinical support area	3.0	3.0		Included above	
Sub-total	16.5	19.0	+2.5	19.0	0.0
En-suite shower room	4.5	4.5	0.0	4.5	0.0
Total for single-bed room	**21.0**	**23.5**	**+2.5**	**23.5**	**0.0**

Table 1: Summary of changes in space requirements for a single-bed room since 2000

Area	SHPN 04 2000 (m^2)	Schedules of Accommodation 2003 (m^2)	Difference (m^2)	SHPN 04-01 2009 (m^2)	Difference (m^2)
Four-bed room	48.0	58.0		64.0	
Clinical support area	3.0	3.0		included above	
Sub-total	51.0	61.0	+10.0	64.0	+3.0
En-suite assisted shower & wash	4.5	4.5	0.0	not included	-4.5
En-suite assisted WC/wash	4.5	4.5	0.0	not included	-4.5
Assisted shower room (en-suite)	not included	not included		6.5	+6.5
Semi-ambulant WC without luggage space (en-suite)	not included	not included		2.0	+2.0
Total for 4-bed room	**60.0**	**70.0**	**+10.0**	**72.5**	**+2.5**

Table 2: Summary of changes in space requirements for a four-bed room since 2000

Executive summary

This Planning Note provides best practice guidance on the planning and design of in-patient facilities for adults. The accommodation described includes:

- bed and sanitary facilities;
- patient support facilities;
- storage facilities;
- utility facilities;
- administration area and staff facilities.

The recommended space standards for bed areas are applicable to in-patient rooms in any setting, including acute, day surgery and community facilities. Schedules of accommodation are available for HBN 04-01, based on a 24 bed ward with options for 50%, 80% and 100% single-bed rooms. These are published on the Space for Health website under 'Spaces and Costs' (http://www.spaceforhealth.nhs.uk/).

In Scotland, 100% single-bed rooms is the requirement for new build facilities and a minimum of 50% is required for refurbishment projects. The 80% single-bed room option therefore will only be considered for refurbishment projects or where a clinical necessity has been established (see paragraphs 1.4 to 1.8).

This best practice guidance essentially applies to 'new build' facilities. However the principles are equally valid, and should be applied when existing accommodation is being upgraded or new accommodation is being constructed within an existing building that may previously have been used for other purposes. This document gives guidance on general and specific design considerations for both patient and support areas. It also covers general functional design requirements and engineering services. Example room layouts are provided in the Appendices along with a comprehensive list of references.

For the current guidance from the Scottish Government Health Directorates on the provision of single-bed room accommodation and bed spacing refer to paragraphs 1.4 to 1.8.

1. Introduction

1.1 This document replaces SHPN 04: 'In-patient accommodation - options for choice' (2000) and provides guidance on the planning and design of in-patient facilities for adults. For particular care groups such as mental health and critical care, reference should also be made to the SHPNs relating specifically to the care group.

1.2 The space standards for bed areas are applicable to in-patient rooms in most settings, including acute critical care (at levels 1 and 0[1]), day surgery and community facilities – some mental health facilities are likely to be an exception. It is important to note that the diagrams throughout this document are provided to support the evidence from the research programme. They are not design solutions and should not be used as such.

It should be noted that teaching hospitals might require some single-bed rooms to be larger to provide sufficient space for students when they are present. These hospitals are also likely to require separate teaching spaces.

1.3 Each project is unique and it is the responsibility of project teams to satisfy themselves that initial briefing and out turn designs are compatible with all their operational requirements. Project designs should continue to evolve and develop innovative solutions that maximise 'in use' flexibility and are affordable.

Provision of single-bed room accommodation and bed space

1.4 The current guidance from the Scottish Government Health Directorates set out in CEL 27 (2010) is as in paragraphs 1.5 to 1.8 below.

New build facilities

1.5 For all new-build hospitals or other healthcare facilities which will provide in-patient accommodation there should be a presumption that all patients will be accommodated in single rooms, unless there are clinical reasons for multi-bedded rooms to be available. These reasons should be clearly identified and articulated in the appropriate Business Case and will be subject to Scottish Government agreement as part of the Business Case approval process.

Refurbishment of existing healthcare facilities

1.6 For projects where existing accommodation is being refurbished it is recognised that each building to be refurbished will present unique problems. Taking into

[1] Levels of critical care as described in 'Comprehensive critical care' (DH 2000): Level 1 Patients at risk of their condition deteriorating, or those recently relocated from higher levels of care, whose needs can be met on an acute ward with additional advice and support from the critical care team. Level 0 Patients whose needs can be met through normal care in an acute hospital. For higher levels of critical care see SHPN 27: 'Intensive care unit' (to be replaced by SHPN 57: 'Facilities for critical care').

account the constraints of the existing building, a minimum of 50% single room accommodation will be allowed but as close to 100% as possible will be expected.

Bed space

1.7 In relation to the issue of bed spacing for multi-bedded rooms, the current advice remains unchanged. That is, taking account of ergonomic criteria, primarily the space required for patient handling and other activities which take place in the immediate vicinity of the bed, it is recognised that the minimum bed space should not be less than 3.6m wide x 3.7m deep.

1.8 When carrying out refurbishment work to existing multi-bedded ward accommodation NHS Boards should seek to achieve this bed spacing. This may require considering reducing the number of beds in the room. NHS Boards should also seek to achieve this bed spacing standard in accommodation which is not being refurbished or replaced.

Policy background

Impact of "Better Health, Better Care Action Plan" on in-patient accommodation

1.9 The Scottish Government's 'Better Health, Better Care Action Plan' (SGHD 2007) sets out a range of measures to improve the quality of Scotland's National Health Service. It gives effect to the Government's commitments to local care whenever possible, embedded in communities and tailored to people's needs. The Scottish Government's key priorities for healthcare therefore require a drive towards locally provided services, including activity that can be safely and effectively provided outside the acute hospital. In-patient accommodation remains largely in acute settings, particularly for complex cases or where major surgery requiring general anaesthesia is required. However, in-patient accommodation may also be provided in community settings for those patients with less complex conditions. Planning teams will need to consider the number of in-patient beds required and where they may be most appropriately located.

Scottish Healthcare Quality Strategy

1.10 The 'Scottish Healthcare Quality Strategy', which is a development of Better Health Better Care, has a number of Quality Ambitions, one of which is that "*there will be no avoidable injury or harm to people from healthcare they receive, and an appropriate, clean and safe environment will be provided for the delivery of healthcare services at all times*". The Quality Ambitions provide the focus for all activity within NHSScotland to support the Scottish Government's aim of delivering the best quality healthcare to the people of Scotland and through this making NHSScotland a world leader in healthcare quality.

1.11 The Strategy itself seeks to improve the quality of care patients receive from the NHS, recognising that the patient's experience of the NHS is about more than speedy treatment – it is the quality of care they get that matters most to them. The Quality Strategy will see the quality of care provided by the NHS measured for the first time through patients' experience and the information used to drive up standards. The Quality Strategy will put patients at the heart of everything the NHS does and give people a new confidence in the health service.

Patient rights and expectations

1.12 The Scottish Government has consulted on agreed ideas on eight different rights for a proposed Patients' Rights Bill. The eight rights are that all of us, as patients, should expect:

- access to health services;
- a right to be treated with dignity and respect;
- a right to safe and effective care;
- a right to be communicated with in a way that each of us can understand;
- a right to information about the services we use;
- a right to be involved in making decisions about care and the services we use;
- a right to privacy and confidentiality, and;
- a right to comment about our care and have any concerns dealt with.

1.13 Thus, increasingly, patients are becoming 'empowered' to demand better environments in which they receive healthcare. It is appropriate that NHSScotland embraces such matters and seeks to deliver facilities that provide the high quality and sustainable caring environments within which patients expect to be treated.

1.14 Preserving the privacy, dignity and confidentiality of patients is essential at all times. Sufficient space is required to allow for both aural and visual privacy during clinical consultation and intervention and at visiting times with family and friends. This must also be balanced with the need for adequate observation of patients by staff.

Prevention of healthcare associated infection

1.15 Control and Prevention of Healthcare Associated Infection (HAI) is a priority issue for NHSScotland – both in respect of the safety and wellbeing of patients and staff and also the resources consumed by potentially unavoidable infections.

1.16 HAI is a complex issue involving the many different elements of patient care and provision. Due to its multi-factorial nature there is a need to develop a

holistic approach to combating the spread of infection within the built environment.

1.17 It is imperative that those involved in the design and planning, construction and refurbishment and on-going maintenance of the healthcare facility have a sound knowledge of prevention and control of infection in the built environment.

1.18 Scottish Health Facilities Note (SHFN) 30 and HAI-SCRIBE aim to provide information on the prevention and control of infection, and on the prevention of cross-infection and cross contamination in healthcare facilities, to those responsible for the planning, design and maintenance of such facilities.

1.19 Cleaning is an essential part of the multi-disciplinary approach in improving patient, staff and public safety. Safe clinical care is supported through ensuring high standards of hygiene and related measures to tackle HAI in the healthcare environment.

1.20 Cleaning regimes including frequency of cleaning should be addressed in line with current national guidance together with any additional Local Management requirements.

1.21 Relevant provisions of current guidance, standards and Codes of Practice for cleaning of healthcare premises and including the latest technical requirements are embodied in the following documents:

- SHFN 30: 'Infection Control in the built environment: Design and Planning';
- HAI-SCRIBE (Healthcare Associated Infection System for Controlling Risk in the Built Environment);
- NHSScotland National Cleaning Services Specification;
- NHS Quality Improvement, Scotland – HAI Cleaning Services Standards;
- The NHSScotland Code of Practice for the Local Management of Hygiene and Healthcare Associated Infection;
- Clinical Standards Board for Scotland HAI Infection Control Standards.

Scale of provision

1.22 The number of patients admitted to hospital each year depends on local workload patterns. The number of bed spaces required will be calculated from factors such as:

- data on number of admissions, number of refused admissions, number of premature discharges, bed occupancy and length of stay;
- local admissions policy;
- future developments influencing demand for acute services, for example increasing day case surgery rates, improved chronic disease management, and the potential for more care at home;

- availability of beds in other settings, for example community hospitals.

Evidence base for this guidance

1.23 Since the previous edition of this SHPN in 2000, considerable work has been carried out to establish how much space is needed around a bed for patient and staff safety, accessibility and clinical need. Subsequent to this work DH published 'Ward layouts with single-bedrooms and space for flexibility' in 2005. This document comprised literature reviews, ergonomic studies and mock-up trials that provided the evidence base for the revised English guidance that has subsequently contributed to this SHPN.

1.24 In addition, with the need for accessibility to en-suite sanitary facilities and the implications for increasing space, evidence-based studies have been carried out to design en-suite shower rooms that will meet the needs of the majority of patients without increasing current space standards. The results of this work were incorporated into HBN 00-02: 'Sanitary spaces' published in July 2008.

2. General functional and design considerations

Location and departmental relationships

2.1 Historically, in-patient accommodation has been the core of the hospital. Now however current trends in the delivery of health services have eliminated in-patient care for some patients who previously would have been admitted. In-patient accommodation however still accounts for a significant proportion of the space in a hospital.

2.2 Patients who are admitted are often acutely ill and in need of observation. One of the primary goals of designers, therefore, is to ensure that staff observation of patients is easily achieved and managed.

2.3 Traditionally, in-patient accommodation has been located either above the diagnostic and treatment floors of a hospital or adjacent to them. Critical care beds are prioritised to be closest to surgical or medical interventions, whereas rehabilitation and long-stay beds can be significantly further away from the core clinical services. In-patient facilities can be organised horizontally over large floor areas or stacked into towers. A recent tendency in the UK has been to put beds into multi-storey wings that are separate from diagnostic and treatment facilities. This allows more consistent planning of in-patient accommodation, increases flexibility in the way that beds can be organised, and enables maintenance and refurbishment to be carried out more easily.

2.4 The location of wards must ensure privacy, particularly at night. Ground-floor locations should be considered only where the adjacent environment is free of hospital traffic and publicly accessible areas. Views outside, together with access to sunshine or direct daylight, have been shown to benefit a patient's recovery. The orientation and aspect of in-patient accommodation must be prioritised when developing a hospital master plan.

2.5 The ability to isolate components of in-patient accommodation is important for infection control, particularly during outbreaks of infectious illness. It is also important in the event of a fire or other emergency, when patients will generally be evacuated to a safe space on the same floor.

2.6 The ability to combine clusters of beds will allow for different needs over time. Support facilities can be more flexibly located.

2.7 Because in-patient accommodation is such a large component of the hospital, its departmental relationships are mostly dependent on the number and location of access points, lifts, and distance from diagnostic and treatment facilities. Small discrete and specialist wards, for example oncology, will require direct access to their own specialist diagnostic and treatment centre within the whole hospital or within the same floor.

Key features of a desirable environment

2.8 Studies (Malkin J, 1992 and Scher P, 1996) have shown that the following features are necessary to provide a desirable in-patient environment.

- Space for:
- clinical activity at the bedside;
- clinical activity elsewhere;
- storage/display of patients' possessions in the bedroom;
- storage of bulky equipment;
- staff support and training;
- social support of patient, including overnight accommodation for a relative/friend in the bedroom.

- Suitability of:
- services and supplies at the bedside for clinical activity;
- access to and within the bedside area for physically and sensory impaired people;
- services to enable personal communication by patient ;
- services to enable direct admin/clinical communication from the bedside;
- a reassuring, stress reducing, environment;
- a safe and hazard free facility.

- Privacy:
- during clerking and clinical discussions between patient and staff;
- during clinical treatment ;
- for bodily functions and personal care;
- for personal discussions and telephone calls;
- for staff communications;
- for staff rest and beverage breaks.

- Patient choice, control, comfort:
- to be alone or in company, including visitors;
- of temperature, ventilation, lighting and sound from the bed;
- of diversion, outlook, entertainment;
- with access to beverages for patients and relatives;
- with local storage of personal belongings of staff;
- with access to the outside world.

Space requirements

2.9 The main issues addressed in the NHS research 'Ward layouts with single-bedrooms and space for flexibility' which established the space required around the hospital bed were:

- meeting the needs of patient privacy and choice;
- contributing to control of healthcare associated infections (HAI);
- complying with the Disability Discrimination Act 1995 and 2005;
- meeting the needs of the Manual Handling Operations Regulations 1992, particularly with regard to lifting patients.

2.10 In addition there is now a great deal more activity taking place at, or close to, the bedside than previously has been the case. These activities fall into three categories:

- clinical treatment and care;
- personal care and maintenance;
- support activities.

2.11 There must be adequate space to carry out the above activities, and also for fixtures, furniture and equipment. The provision of sufficient space will enable these activities to be carried out comfortably, easily and safely, and without obstruction.

2.12 The provision of sufficient space in clinical areas, particularly for each bed space, is one of the most important considerations in the planning and design of in-patient accommodation. Ergonomic studies have established that most activities carried out at the bedside can be accommodated within the dimensions 3.6m (width) × 3.7m (depth). This represents the clear bed space and does not include space for fixed storage, clinical support zone, family support zone, preparation and worktops. It is important to ensure that there is adequate access for cleaning and that bedrooms and bed areas are easy to clean. Space requirements are discussed more fully in Section 3 and also some typical room layouts are included in the Appendix 1.

Sanitary facilities

2.13 For infection control purposes, in-patients, clinical staff and visitors require to be provided with separate sanitary facilities, these must be clearly labelled. Facilities for visitors and non-clinical staff will be located close to the ward reception and waiting area. Sanitary facilities for clinical staff may be provided in association with staff changing and rest room areas. Where staff changing and rest rooms are located away from the ward, a designated WC for clinical staff will generally be required in the ward. Sanitary facilities for in-patients must be located en-suite to bed areas.

2.14 All single-bed rooms (and multi bedded rooms if provided) must have en-suite sanitary facilities. The increasing acuity of illness of in-patients means that a great proportion of patients may require assistance during their hospital stay. For greatest flexibility of use, all sanitary facilities in in-patient areas should be accessible and manageable by people with physical or sensory disabilities with or without assistance.

2.15 As part of the development of the DH guidance, research was carried out into the size and layout of en-suite shower rooms to identify a space-efficient design that would, as far as possible, meet the needs of the majority of patients. It was acknowledged during the research that some aspects of ambulant/semi-ambulant/independent wheelchair access and assisted use are not compatible. For example, the provision of a wash-hand basin next to the WC for independent wheelchair users would have conflicted with access for patients requiring assistance. As the number of patients requiring assistance is likely to be greater than the number of independent wheelchair users in in-patient accommodation, the primary concern should be to provide space and facilities for people requiring assistance. Certain limitations on independent access are therefore considered acceptable within a healthcare setting.

2.16 The new layout for an en-suite shower room forms the basis for the guidance and example layouts in this SHPN. There should be access to a fully assisted bathroom or shower room where shower trolleys may be used. This could be shared between adjacent wards and is listed as essential complementary accommodation in the schedules of accommodation. Alternative layouts for en-suite sanitary facilities are described in HBN 00-02: ‘Sanitary spaces’.

Hand hygiene

2.17 Antibacterial hand-rub dispensers should be provided at the ward entrance.

Figure 1: Hand rub dispenser

2.18 Each room must contain a clinical wash-hand basin[2]. The basin should be located so as to be highly visible to staff entering and leaving the room and convenient for them to use. The use of sensor taps may be appropriate to reduce the risk of infection

In projects where four bedded rooms are included, two clinical wash-hand basins should be provided, one close to the entrance to the room and the other placed in an obvious and convenient position for staff working at the other end of the room. The multi bedded room layout in Appendix 1 indicates a possible location of clinical wash-hand basins.

2.19 For further guidance on clinical wash-hand basins refer to SHTM 64: 'Sanitary assemblies' and HBN 00-03: 'Clinical and clinical support spaces'. Infection control advisors should always be consulted regarding these basins to confirm that the proposed arrangement is acceptable for each project.

Isolation facilities

2.20 Single-bed rooms provide the most effective facility for isolating patients with a variety of infections, such as MRSA. However in some circumstances it may be necessary to provide a higher level of isolation, particularly for those patients with airborne diseases or for immuno-suppressed patients who may be at risk of infection from others. In these cases an isolation suite will be required; this will include an entrance lobby, bedroom and en-suite sanitary facilities. This is listed as optional in the schedule of accommodation. The need for, and number of, isolation suites should be decided locally and in consultation with local Health Protection Scotland staff. Also refer to SHPN 04 In-patient Accommodation: Options for Choice Supplement 1: 'Isolation Facilities in Acute Settings' (2008).

Isolation suites are described in paragraph 3.24.

Cleaning services

2.21 Recent research ('An integrated approach to hospital cleaning', DH 2007) indicates that a microfibre system for day-to-day cleaning in combination with periodic steam cleaning is an effective approach to cleaning in-patient facilities. The guidance in this SHPN is based on this approach. If other cleaning systems are to be adopted, design teams should give careful consideration to the facilities required in each case.

2.22 In terms of facilities, a microfibre system requires:

- space for storing the microfibre cleaning trolley and clean microfibre cloths and mops (the cleaners' room, see paragraph 3.47);
- space for holding dirty microfibre cloths (the disposal hold, see paragraph 3.48);

[2] The requirement for a clinical wash-hand basin in the room may not apply to all mental health facilities.

- suitable laundry facilities for washing and drying used microfibre cloths.

2.23 The laundering of microfibre cloths and mops requires special conditions and dedicated facilities. The laundry process should be carefully managed. Project teams should decide locally whether laundry facilities are provided in-house or contracted out. More information on the laundering of microfibre cloths is contained in the research and development report, available through the Department's KIP website at http://estatesknowledge.dh.gov.uk.

2.24 A supply of disposable cleaning materials requires to be stored locally for clinical staff to use when the cleaning staff are not available. These may be held separately in the dirty utility room.

2.25 This guidance assumes that steam cleaning equipment for periodic deep cleaning will be stored centrally and brought to the ward as required. Storage space for this equipment on the ward is not required.

Decontamination of equipment

2.26 The effective decontamination of medical devices is essential in reducing the risks to patients from HAI. Facilities for decontaminating medical devices will ideally be provided in a Central Decontamination Unit (CDU).

2.27 Reference should be made to advice and guidance in SHTM 2010: 'Sterilization', SHTM 2030: 'Washer disinfectors' and SHTM 2031: 'Clean steam for sterilization' (all to be replaced by SHTM 01-01). Further information can be obtained from the Medicines and Healthcare products Regulatory Agency (MHRA) – see http://www.mhra.gov.uk/Safetyinformation/Generalsafetyinformationandadvice/Technicalinformation/Decontaminationandinfectioncontrol/index.htm.

Reference should also be made to SHPN 13: 'Decontamination facilities' (published in three parts) and SHFN 30: 'Infection control in the built environment'.

Ward size

2.28 The schedules of accommodation on the Space for Health website are based on HBN 04-01 and a ward of twenty four beds. These are generally compatible with SHPN 04-01 but Project Teams may require to modify them to suit individual projects.

2.29 The twenty four bed ward has been selected as an example only, chiefly because this size is common throughout NHSScotland hospitals. It also supports the assumption that an eight-bed cohort is the preferred workforce planning unit, with one clinician and one support worker caring for each cohort, although this may vary according to the dependency level of patients in a cohort. Wards may be larger or smaller than the twenty four bed example. The number of beds in each ward should be determined locally.

Observation and communication

2.30 Clinical staff must be able to observe and communicate easily with patients. Many clinicians consider that engagement with patients improves in a single-bed room environment because with better privacy, communication improves and they are able to complete a whole episode of care privately without being disturbed by others.

2.31 Careful design can support good observation. For example, glazed walls or very large windows between rooms and corridors will enable staff to observe patients and, equally importantly, patients to see staff. Views into busy internal spaces such as circulation areas can provide a distraction for patients and are just as important as views of the outside world. Patients should have the means to obscure windows if required. For example, integral Venetian blinds that can be lowered and closed to provide privacy.

Figure 2: An example of good observation into a single-bed room

2.32 In addition to observation through windows, the use of electronic surveillance equipment such as cameras may be considered. However, in order to guard against the potential invasion of privacy, patients must be able to choose whether cameras in their bedroom are switched on or off. In particular, the dignity and safety of patients with mental health conditions and patients who may be in a state of confusion must be carefully considered.

2.33 Use of a two-way speech facility as part of the help call system can be reassuring for patients and can reduce journey frequencies for staff.

Two-way speech facilities can be made significantly more effective by including an option to enable staff to key in and out of rooms (staff presence). Smart technology allows such systems to be automated so that each member of staff wears a radio frequency identification (RFID) tag that remotely indicates their

presence. This function allows staff to locate, and communicate with, each other more effectively. These facilities are particularly relevant now in wards with 100%, or a high percentage, of single-bed rooms. Call systems must operate on a 'follow the light' principle whereby over-door lights and discrete indicator units mounted at strategic positions (staff rest rooms etc) guide staff to the call origin. In addition this can be supplemented by the use of Wi-Fi/IP technology, which can be interfaced with other site communication facilities (for example single staff handset, which combines phone, pager, cardiac and help call facilities).

Clinical administration

2.34 Advances in IT are enabling clinicians to move away from traditional paper-based patient records towards more flexible computer-based systems. Electronic patient records (EPR) and picture archiving and communication systems (PACS) mean that a significant amount of direct clinical administration can now take place at the bedside using a computer.

2.35 Wireless and infra-red technologies provide an alternative to networked computers in fixed locations. They enable EPRs to be accessed from laptops and other mobile and hand held devices that can move with staff between clinical spaces. Where computers are fixed in bed areas, designers should ensure that patients will not be disturbed by the light from VDUs or by staff entering data at night time.

2.36 This Planning Note describes two types of workstation for clinical administration:

- in bedrooms: a simple workstation with space for recording clinical data. In multi bedded rooms, one workstation serving all four beds is sufficient;
- touchdown base: a workstation located close to patients but not within single-bed rooms or multi bedded rooms. This is where EPRs can be accessed and updated. The touchdown base is at standing height with a perching stool. There should be a number of touchdown bases throughout the ward, which may be located in a variety of ways:
- a dedicated touchdown base immediately outside each bedroom; or
- a touchdown base shared between a pair of bedrooms; or
- a touchdown base serving a small cluster of bedrooms.

2.37 It is assumed in this guidance that there is no central staff base, as staff will be working locally throughout the ward unit. It is recognised, however, that this is only one design solution and that planning teams may wish to include a central staff base. See paragraph 3.28 and for further guidance on staff communication bases, refer to HBN 00-03: 'Clinical and clinical support spaces'.

Figure 3: Working at a touchdown base

2.38 The greeting of patients and visitors, and general administration, will be carried out at the ward reception desk by clerical staff. Depending on the layout of wards, the reception desk could be shared between two or more wards.

2.39 Pre-admission and post-discharge correspondence, private telephone calls and patient handover meetings may take place in the office/meeting room.

2.40 See Section 3 for detailed descriptions of clinical administration spaces.

Moving and handling patients

2.41 Patient moving and handling tasks are associated with the greatest proportion of staff musculoskeletal disorders in the health services (HSE 2001). One way of avoiding such injury is to move patients by use of a hoist, which requires sufficient space around the bed for staff to perform these tasks and to manoeuvre the required equipment around the bed.

2.42 If mobile hoists are to be used, designers must ensure that there is sufficient space within the ward to store them. Other devices for transferring patients will also need to be stored.

2.43 If ceiling mounted hoists are preferred, designers will need to consider the potential conflict with medical service units, patient entertainment systems and where tracks go through walls above doorways into the ensuite facilities. Consideration must also be given to the ‘parking’ of the hoist sling when not in use. Where ceiling mounted hoists are installed, there will still be a need for some mobile hoists, for example for lifting patients who may have fallen beyond the reach of the ceiling track. Design teams will need to consider adequate storage space for these.

The use and positioning of ceiling mounted hoists in isolation suites requires careful consideration. See paragraph 3.25.

Careful consideration will also be required in the positioning and detailing of ceiling hoist tracks where there are services in the ceiling, such as ceiling mounted radiant heating panels.

In multi-bed rooms the hoisting of patients around the bed space may compromise their privacy and dignity. The use of hoists should be restricted to bed to chair, trolley or wheelchair transfers only.

2.44 The decision on the extent of lifting equipment provided will depend on several factors including the patient profile, and should be decided locally.

2.45 For further guidance on the space required for moving and handling patients see 'Ward layouts with single rooms and space for flexibility' DH, 2005 and 'Risk assessment and process planning for bariatric patient handling pathways' HSE, 2007.

Separate treatment room

2.46 In a ward of 100% single-bed rooms the provision of a separate treatment room is optional, as procedures that cannot be undertaken at the patient's bedside will take place in the appropriate departments. Wards with a combination of single-bed rooms and multi-bed rooms will require a separate treatment room. For further guidance see paragraph 3.28.

Supplies, storage and disposal

2.47 Supplies, storage and disposal are whole-hospital issues. An increasing number of UK hospitals have adopted a 'just-in-time' supplies system, which involves a large centralised store on each site. These central stores keep all non-specialised clinical supplies for regular distribution on a 'top-up' basis to the different departments when required. Local policy will influence how much storage space is needed within or adjacent to acute wards.

2.48 Two options for delivering and storing clean supplies and consumables are:

- Option 1: Local clean utility room
- Each ward contains a clean utility room, which is restocked regularly from the hospital's central stores and pharmacy. Clinical supplies for individual bedrooms are held on supplies trolleys, which are topped up in the clean utility room and then parked in the clinical support area of each bedroom. Medicines are stored and prepared in the clean utility room. See Figure 4;
- Option 2: Shared clean supply room plus local medicine store/preparation room
- Clinical supplies are stored in a clean supply room serving a number of wards. Clinical supplies trolleys are restocked here and then returned to patient bedrooms where they are parked in the clinical support area. Medicines are stored and prepared separately in the ward's medicine store/preparation room. See Figure 5.

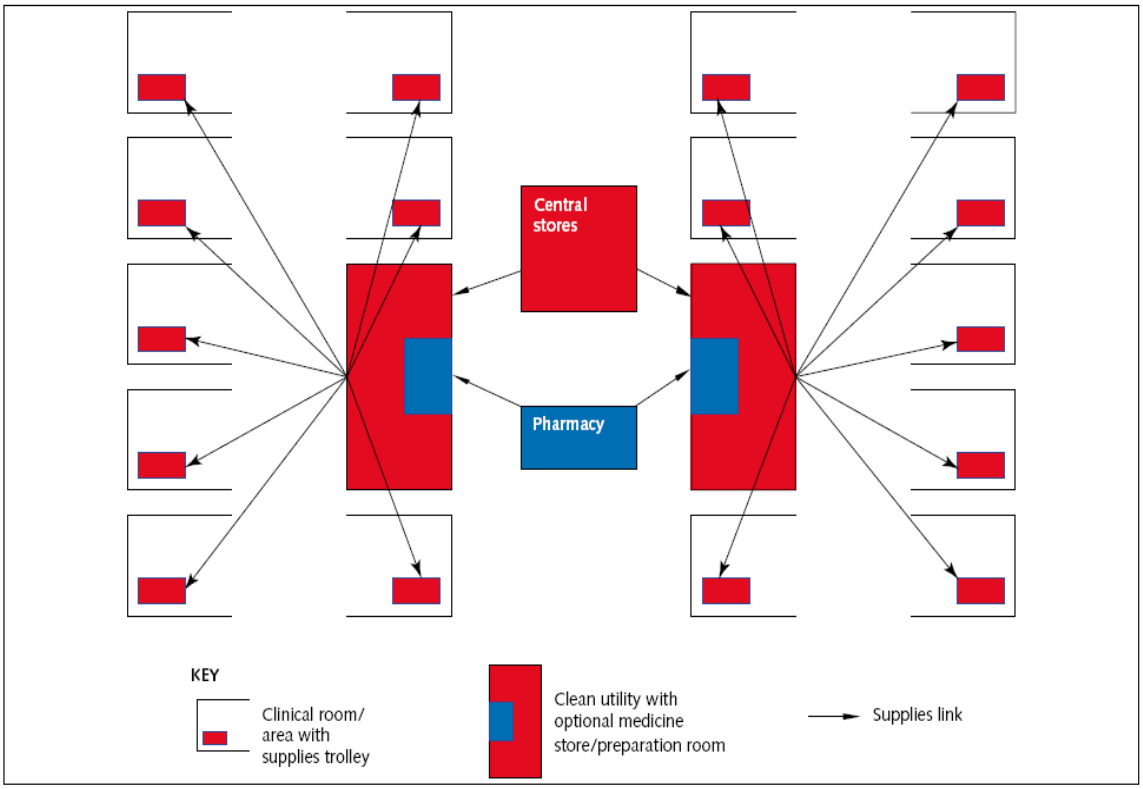

Figure 4: Option 1 – Central store and clean utility room

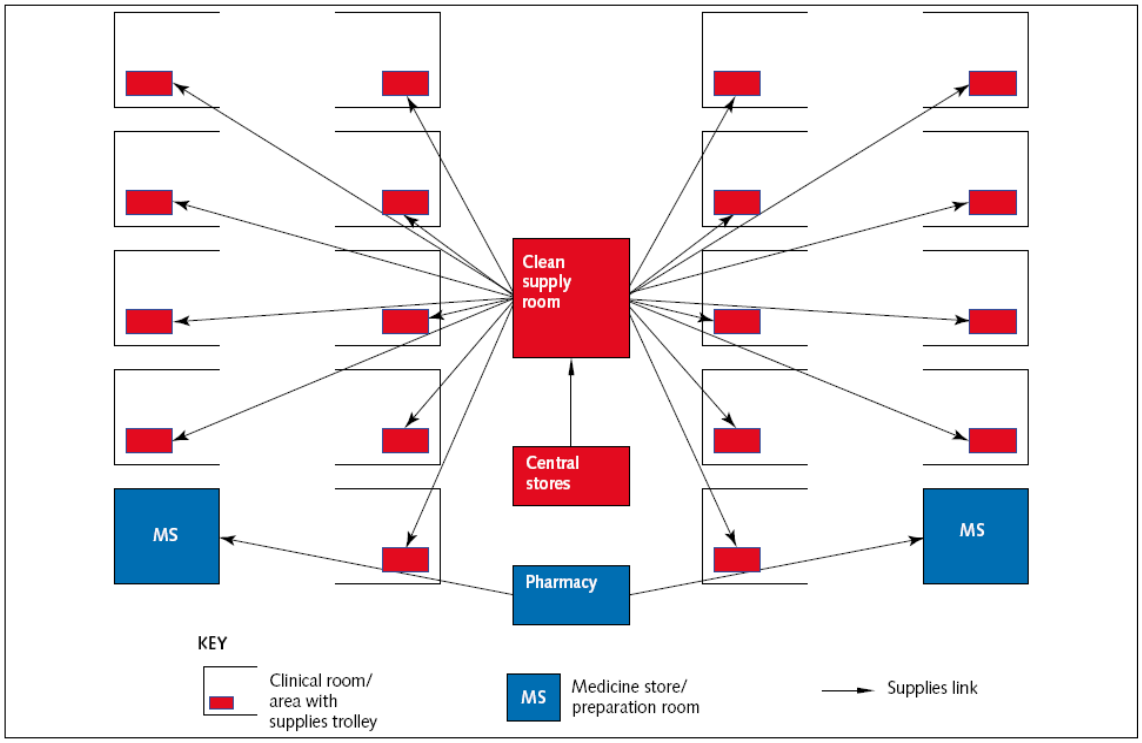

Figure 5: Option 2 – Clean supply room and medicine store/preparation room

2.49 The Space for Health schedules of accommodation are based on Option 2, which is the provision of a shared clean supply room (essential complementary accommodation) and a local medicine store/preparation room. The provision of a clean utility room instead of a clean supply room and medicine store/preparation room is optional.

2.50 Items for disposal will be placed in the disposal hold. Some items will be held temporarily in the dirty utility room before being transferred to the disposal room.

2.51 Design teams must ensure that supplies policies and storage systems are agreed early in the design process, as they generally have a significant impact on planning and room areas. See also paragraphs 3.39 to 3.44.

Dirty utility room

2.52 Generally it has been accepted that a dirty utility room should serve no more than 15 beds to reduce travel distances for staff, making better use of nursing time and reducing the risk of spillages and cross-contamination. A second dirty utility room on a ward is also helpful during outbreaks of illness or infectious diseases. The Space for Health schedules of accommodation includes two dirty utility rooms for a 24 bed ward. Depending on the ward design it may be acceptable to have only one room as with the Hillingdon Hospital single-bed room pilot ward where the bedrooms are located in three short wings of eight beds and the utility room is in the central support zone.

Education and training facilities

2.53 Staff education is important in acute wards, and appropriate facilities will be required. Trainee clinical staff will form a proportion of staff working in acute areas. While some teaching takes place in the clinical area on a one-to-one basis or in small groups, the teaching of large groups can be an imposition on the function of the area. A seminar room, which may be shared with other wards, should be provided as essential complementary accommodation. See paragraph 3.64 for design requirements.

Lighting

2.54 Scientific evidence (Rubin & Owens 1996) indicates that daylight has beneficial effects on patients, visitors and staff. It has been shown to reduce psychological problems, improve patient outcomes, increase morale and reduce sickness levels amongst staff. An external view is also extremely beneficial, even if limited. Windows should always be located so that the patient can see out from their bed, and sized to provide an acceptable level of natural light.

All bed areas should receive natural daylight. Where artificial lighting is provided in spaces where patients are examined or treated, it must enable changes in skin tone and colour to be clearly defined and easily identified. Artificial lighting should be colour-corrected. The quality of lighting will need to be considered if video consultation is likely to take place. Lighting is also important for effective cleaning of corners and edges that can harbour dust. Adjustable task lighting requires to be provided at the bedhead to allow patients to read.

2.55 To avoid glare and discomfort to patients, ceiling-mounted fixed luminaires must not be sited immediately above positions where they may be lying on a bed, couch or trolley. This also applies to all spaces where people are consulted, examined and treated. Consideration should be given to patient control of the lighting in single-bed rooms.

Refer to paragraph 4.46 for more detailed guidance.

Views from windows

2.56 Wherever possible, bedrooms in new developments should be located in positions to enable patients to have a view of the outside world. The view can either be of external distant views, landscaped gardens or suitably sized courtyards with good-quality natural planting. Small 'light-wells' should be avoided, particularly as they may allow bedrooms to be overlooked. Window cill heights must be low enough to allow patients in beds and seated people to see outside. Views ideally should include ground and sky, 'busy' views are considered beneficial for some patients. Views out over blank walls, other close by buildings, flat roofs and roof top plant rooms etc. are to be avoided. For further information see 'Does the environment affect staff and patients health outcomes?', DH R&D Project 2006.

2.57 The means for patients to control curtains or blinds from the bed for comfort and privacy should be included, motorised blinds/curtains are an option for non-ambulant patients. For further guidance refer to SHTM 55: 'Windows'.

Courtyards

2.58 Well designed and suitably proportioned, courtyards enable rooms to receive natural daylight and ventilation in addition to providing a stimulating outlook. The form of the layout and planting can help to preserve privacy in surrounding rooms. Courtyards may also provide a suitable location for artwork. The level of ongoing maintenance needs to be carefully considered.

2.59 It is necessary to provide access to courtyards. Where courtyards provide recreational space all doorways, thresholds and ramps must be designed to facilitate access for all patients, staff, visitors, etc. In some situations patients may require to access these areas while on their beds. Seating should be provided and short lengths of handrail should also be provided at strategic points around the courtyard for patients who need support. Access for maintenance and cleaning should be located so that patients and staff within the building are not disturbed. Adequate water points, power points and lighting should be provided where required.

Figure 6: Courtyard, Queen's Centre for Oncology & Haematology, Hull

(Reproduced with the permission of HLM Architects – photographer Ian Bruce)

Art

2.60 There is now sufficient evidence to demonstrate that appropriate art and decor reduces the physical and emotional stress of patients and staff. It can also be used to assist with wayfinding. Art should be integrated into a scheme rather than added as an afterthought.

2.61 Works of art and craft often lend special identity to individual spaces and help give a sense of locality. Care should be taken to cater for all age ranges. A proposal for very young in shared areas might not be appreciated by older children.

2.62 Advice should be sought from experts on:

- obtaining grants. In some cases, moneys for art within a capital scheme can be matched by grants from charities or regional arts boards;
- ensuring quality in all art and craft works;
- appropriately locating art and craft works;
- selecting artists and craftspeople.

2.63 Art need not be limited to pictures on a wall. It can also include furniture, prints, murals, photographs, sculptures, floor designs, decorative tiles, ceramics and textile hangings. Works of art by local artists and craftspeople may lend a special identity to the facility.

2.64 Careful consideration should be given to the ease of cleaning and minimizing dust traps when choosing artworks. Design teams should seek the advice of the infection control team as to the suitability of all proposed artworks in clinical areas.

2.65 For further guidance refer to 'The art of good health – A practical handbook' and 'The art of good health – Using visual arts in healthcare' (both 2002 DH publications and available from The Stationery Office).

Environmental control

2.66 As noise is such a significant issue for patients, design that separates busy activity areas and patient bed spaces and the use of sound absorbing materials should be adopted. Partitions and ceilings between areas for confidential discussions must be sufficient to prevent overhearing (see SHTM 2045: 'Acoustics' - to be replaced by SHTM 08-01).

Telephone, TV and radio facilities

2.67 It is beneficial for patients to have convenient access to telephone, TV and radio facilities. Planning teams should identify suitable systems to meet local requirements. For guidance on the use of Mobile phones see 'Guidance on the use of Mobile Communication Devices in healthcare premises' (HFS 2008).

Finishes

2.68 The choice of finishes will form an integral part of the design process and be co-ordinated within the overall design scheme. The selection of colours and reflectance quality can have a significant impact on the lighting within the room and will need to be coordinated with the lighting design. Finishes must also be functional and compatible with the need for comfort, cleanliness and safety. Cleaning regimes require to be considered when selecting materials. The advice and/or approval of the infection control team and FM provider should be sought throughout the project, but particularly at the specification stage.

Floors

2.69 Flooring should be smooth, impervious, easily cleanable and wear-resistant. All patient access, clinical, support, etc. rooms will require coved skirtings. These allow easy cleaning and avoid microbial colonisation. The material used for skirtings must be integral with, and have similar properties to the floor finish. In areas where frequent wet cleaning methods are employed, the flooring material must be unaffected by disinfectants.

2.70 Carpets must not be used in clinical areas. Short pile carpets may possibly be considered for use in offices and the seating areas of staff rest rooms, but not for reception areas. Carpets are extremely difficult to keep clean and need to be

meticulously maintained so very careful thought must be given before specifying their inclusion.

2.71 All flooring should be slip-resistant. Design teams could also consider the use of impact-absorbing floor finishes, which will reduce the severity of injury should a patient fall and also the level of impact noise.

2.72 For further guidance on the selection of flooring refer to SHTM 61: 'Flooring' (HFS) and 'Safer surfaces to walk on – reducing the risk of slipping' (CIRIA 2006).

Walls

2.73 Wall finishes must be durable and where appropriate able to withstand repeated wet cleaning and the accidental impact of trolleys and mobile equipment. Especially vulnerable points and corners will require additional protection. Smooth paint surfaces are the easiest for cleaning, for example eggshell or vinyl silk emulsion. Matt finishes are not recommended and all paints used should be solvent free.

2.74 Walls in kitchen, shower and toilet areas require to be easily cleanable. The advice of the infection control team should always be sought.

2.75 For further guidance see SHTM 56: 'Partitions' and for handrails on walls in circulation areas, refer to HBN 00-04: 'Circulation and communication spaces'.

Ceilings

2.76 Adequate ceiling heights in clinical areas are crucial. The underside of a finished ceiling in bedded areas will require to be at least 2700mm from the floor. There may be difficulties in complying with ceiling heights throughout the hospital in the case of refurbishments, but within a new build facility the required heights should always be achievable.

2.77 Care must be taken when assessing the correct position and weight bearing factors for hoists and other lifting equipment, lighting, patient entertainment and data management systems.

2.78 The use of acoustic ceiling materials in corridors and public spaces such as waiting areas may be helpful in reducing noise levels.

2.79 The design team, infection control officer and facilities manager require to work together to ensure that the choice of ceiling and the maintenance routines are satisfactory and compatible. Service access panels should be avoided in bedrooms wherever possible.

For further guidance refer to SHTM 60: 'Ceilings' (HFS).

Doors and frames

2.80 Materials used for doors and frames should be able to withstand frequent impact from mobile equipment and also must be easily cleanable. All double-swing doors will require appropriate glass vision panels. For privacy, safety and other considerations bedroom doors require the panels to be capable of being obscured. Integral blinds are one option that should conform to infection control strategies.

2.81 Sometimes it may be desirable to secure certain doors in the open position for a period of time. In the case of fire doors this must only be by means of an approved or recognised product linked to the fire alarm and detection system. These will require to fail to safety which is the closed positions. Magnetic door retainers must not restrict the movement of traffic.

2.82 Reference should also be made to SHTM 58: 'Internal doorsets', HBN 00-04: 'Circulation and communication spaces' (which includes updated information on doorsets) and NHSScotland Firecode SHTM 81: 'Fire precautions in new healthcare premises'.

Windows

2.83 Guidance on types of window and their safety aspects is available in SHTM 55: 'Windows'.

In addition to the guidance and various statutory requirements, the following issues require consideration:

- daylight and prevention of glare;
- safety;
- natural ventilation and user comfort;
- views;
- attenuation of noise;
- ease of use;
- energy conservation, solar control (the use of tinted glass and films should be avoided due to their effect on patient well-being - see research);
- control of blinds/curtains from the bed; and
- the provision of a visual link with the outside world balanced with the need to obscure the views into some areas from the outside.

2.84 Windows in single-bed rooms should be openable. Where ward accommodation requires mechanically cooling to prevent the summer ambient temperature exceeding the prescribed limit, a regime of closing windows when the cooling is in operation needs to be employed. Opening windows above ground floor will require safety restrictors.

2.85 All windows must be double glazed as a minimum to provide thermal and sound insulation.

2.86 It should be possible for cleaners to gain easy safe access to the inside and outside of all windows.

Maintenance and cleaning

2.87 Materials and finishes should be selected to minimise maintenance and be compatible with their intended function. Building elements that require frequent redecoration and are difficult to service or clean must be avoided. Special design consideration requires to be given to entrances, major circulation routes, corners, partitions, counters and all other elements that may be subjected to heavy use. Wall coverings should be chosen with cleaning requirements and regimes in mind.

Wayfinding

2.88 The use of colour and art to identify particular routes and rooms can help to reduce the number of signs required. Certain doors, for example fire exit doors, will require conventional labelling. Where signs are used they should not detract from the overall ambience, and should be simple yet sufficiently explicit to be understood without being confusing. Names of departments, areas and rooms should be consistent to avoid confusing patients, visitors and new staff.

Reference should be made to NHSScotland Wayfinding: 'Effective Wayfinding and Signing Systems - guidance for healthcare facilities' (HFS).

Security

2.89 There are a number of security issues to be considered in the planning and design of in-patient accommodation. These include access control, windows and doors, natural and mechanical surveillance (CCTV), lighting, wayfinding, security of property and assets, security of drugs and the protection of NHS staff against violence. The Local Security Management Specialist (LSMS) or Security Advisors will be able to identify security risks and offer advice on measures that can be implemented to reduce them.

2.90 Where entryphone/intercom systems and CCTV are installed, they will require to be linked to the reception desk and appropriate touchdown bases in order to control access through the main entrance. The LSMS should be consulted on the installation of all access control systems.

Fire safety

2.91 It is important to establish during the design stage those aspects of fire safety strategy that affect the design, configuration and structure of in-patient

accommodation. The design team will require to discus and verify their proposals with the Client's Fire Safety Advisor and the local Building Control Authority. The design team and all other design staff must be fully acquainted with the fire safety strategy for the design in terms of operation (staff responsibilities, equipment provision, and building and engineering layouts). For further guidance refer to 'Fire policy for NHSScotland', CEL 25 (2008) and NHSScotland Firecode; in particular SHTM 81: Part 1 'Fire precautions in new healthcare premises' and Part 2 'Guidance on the fire engineering of healthcare premises' if appropriate. It should also be noted that, when occupied, the compliance provisions of the 'Fire (Scotland) Act 2005 as Amended' and the 'Fire Safety (Scotland) Regulations 2006' must be met, including the requirement to conduct fire risk assessments.

Compliance with statutory and other requirements

2.92 As far as possible this guidance takes account of statutory and other requirements as well as guidance in force, or available, at the time of publication. The following is intended only as a brief summary of compliance requirements.

People with accessibility difficulties (Disability Discrimination Act 2005)

2.93 Boards must comply with the provisions of the Disability Discrimination Act, 2005 (to be replaced late 2010 by the new Equality Act) and the relevant sections of the Scottish Building Regulations. Reference should also be made to BS 8300:2009 'Design of buildings and their approaches to meet the needs of disabled people – Code of Practice'. Design teams should also refer to HBN 00-02: 'Sanitary spaces', HBN 00-03:'Clinical and clinical support spaces' and HBN 00-04: 'Circulation and communication spaces'. These set out the standards required specifically for healthcare premises and are in some cases are more demanding than other more general guidance. Reference should also be made to NHSScotland 'Wayfinding: Effective Wayfinding and Signing Systems - guidance for healthcare facilities' (HFS).

Manual Handling Operations Regulations 1992

2.94 Manual handling and health and safety regulations relate to lifting and turning patients and moving heavy equipment. They state that 'Each employer shall, so far as is reasonably practical, avoid the need for his employees to undertake any manual handling operations at work which involve a risk of their being injured'. Client Project Teams should consider the increasing numbers of overweight and obese patients. Client Project Teams and their design teams should take these into account when designing facilities. Refer also to paragraphs 2.41 – 2.45.

The Construction (Design and Management) Regulations 2007

2.95 These regulations, and the related Approved Code of Practice, focus attention on health and safety planning and management throughout construction projects, from design concept onwards. Designers have a duty to eliminate hazards and reduce risks. Planning teams have a duty to provide project-specific health and safety information needed to identify hazards and risks.

Safety regulations

2.96 A selection of health and safety regulations are included within Appendix 2: References.

Environmental Protection

2.97 Various acts, some specific to Scotland, are listed within Appendix 2: References.

3. Specific functional and design requirements

Functional relationships

3.1 A twenty four bed ward may function as a stand-alone unit that has beds grouped into two or more clusters. Depending on the layout of in-patient floors bed clusters may be configured to allow them to be shared between, or 'attached' to, adjacent wards in order to provide flexibility. See Figure 7.

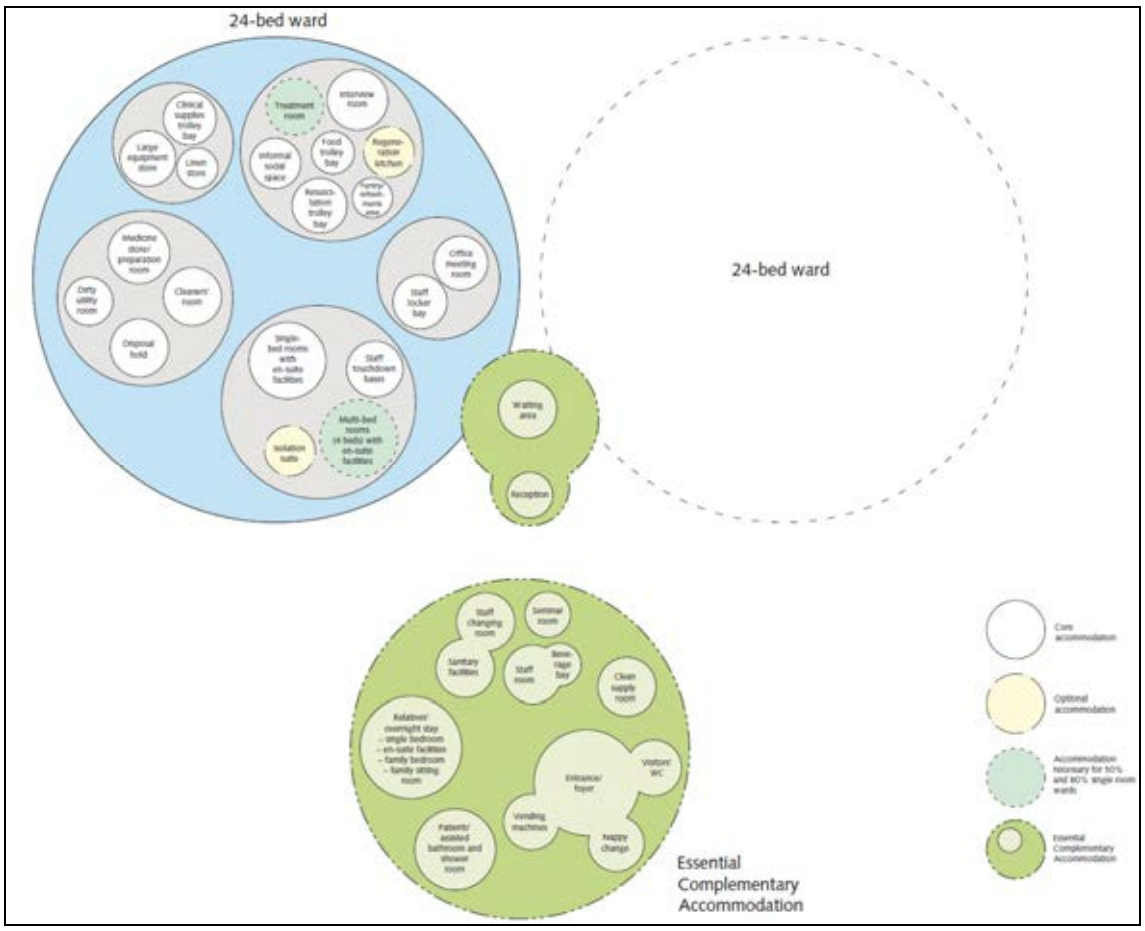

Figure 7: Functional Relationships

3.2 Each bed cluster will be serviced by staff and support facilities, therefore access to supplies and means of disposal should ideally be local to each cluster. It is recommended that rooms be serviced by trolley, like hotels, so that staff do not need to walk far from their bed cluster unless they require access to a shared facility, for example the medicine store/preparation room. The preferred option will be to stock each room for linen, clinical consumables and disposable items, and rely on 'just-in-time' and 'top-up' supplies.

3.3 The reception desk will be at the entrance to a ward or group of wards it is serving, together with a waiting area and toilet facilities for visitors. The

entrance to the ward accommodation is usually controlled by staff via an intercom system.

3.4 Regeneration kitchens should not be situated centrally within a ward, although the food trolley bay will need to be located between the bed clusters.

3.5 Ward layouts will ultimately depend on local conditions and overall bed numbers.

Description of room spaces

Bed and Sanitary Facilities

Bed spaces

3.6 The number of activities taking place at the bedside is increasing. The period that a patient spends in hospital is shortening, and is limited to active interventions for diagnosis, treatment and immediate recovery. The level of acuity and dependence of patients once interventions begin until discharge is relatively high; movement by staff around the patient may be considerable, and there is likely to be an increasing but intermittent use of equipment and aids at the bedside. The activities and the patient's response to interventions are recorded, increasingly on computer held databases. Relatives and visitors are encouraged to be more involved in patient care and support.

3.7 There are three distinct categories of direct activity that take place:-

- clinical treatment and care:
- admission, with the intimate discussion of personal matters;
- specific medical and nursing interventions and observation;
- rehabilitation;
- informing, discussing, listening and advising both patients and relatives.
- personal care and maintenance:
- sleeping and resting;
- eating, drinking, washing and toileting;
- entertainment/diversion, reading, watching the television;
- receiving visitors.
- support activities;
- preparation of clinical procedures;
- maintaining records;
- holding stores;
- communicating;

- developing staff skills.

3.8 The example layouts for a single-bed room in Appendix 1 shows the zones to enable these activities to take place around a bed space.

3.9 The bed space should allow procedures to be carried out from either side of the bed with adequate circulation space so that medical emergency teams and equipment can gain access to the patient. There should be adequate space for moveable furniture and unobstructed access for wheelchairs, as well as space to accommodate overnight visitors.

3.10 The alternative to a single-bed room is a multi-bed room. These will only occur in refurbishment projects or in new build projects where a clinical need has been established. In a multi-bed room the different activity zones move to a greater or lesser degree further away from the bedside, and may be shared to support all the beds in the room. The acceptable maximum number of beds in a multi-bed room is four as it gives each patient a corner as a 'home base' and a neighbour on one side only.

A high percentage of single-bed rooms within a twenty-four bed ward will provide the flexibility necessary to allow gender separation and improved privacy.

3.11 All single-bed and multi-bed rooms must be provided with en-suite sanitary facilities and, whether in a single-bed or a multi-bed room, all bed spaces should be provided with:

- furniture:
- a variable-height bed;
- a bedside locker, with a lockable compartment for storing medication;
- an over-bed table;
- an easy chair;
- a bedhead luminaire, task lighting (see Para 2.53).
- a coordinated bedhead services arrangement incorporating:
- electrical socket-outlets;
- luminaire control switch;
- oxygen, medical air and vacuum outlets (refer to SHTM 2022: 'Medical gas pipeline systems' to be replaced by SHTM 02-01);
- a patient services system (which may be incorporated into the bedhead services panel) including:
- help call button, including two-way speech facilities (see paragraph 2.32), consideration might also be given to alternative call systems, such as blow devices, for patients who cannot use their hands;
- reassurance light;

- luminaire switch.
- patient entertainment facilities including:
- radio;
- TV;
- telephone;
- headset outlet.
- Additionally, in single-bed rooms:
- space for storing clothes and shoes;
- space for a relative's overnight stay bed;
- a small refrigerator for a patient's personal use (optional);
- Facilities for staff:
- a workstation with at least a double data outlet;
- a worktop with space below for clinical supplies and disposal;
- a clinical wash-hand basin (two required in 4-bed rooms), plus antibacterial hand-rub dispensers;
- storage for a day's supply of linen and surgical goods/supplies.

These provisions are necessary as the basis of a desirable environment.

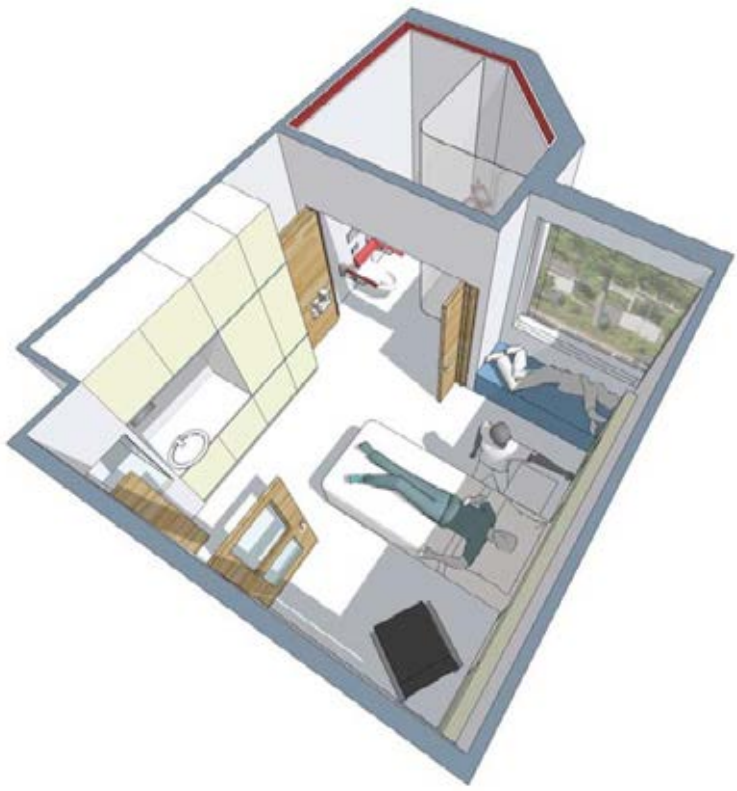

Figure 8: Single-bed room layout Hillingdon Hospital

3.12 Where the provision of multi-bedded rooms has been agreed, each bed space must be separated to provide a degree of privacy. If curtains are used they require being shadow-proof and flame- retardant. When full-height curtains are drawn the bed space must still be well illuminated and ventilated. Curtains may be disposable. Highly patterned curtains should be avoided, as they can cause visual disturbances in patients who are confused or heavily sedated.

3.13 Each four-bedded room must include two clinical wash-hand basins for staff use. These will be located so as to be highly visible and convenient for staff to use on entering and leaving the room and also when moving from one patient to another. A workstation is required for each multi bedded bay with space for a computer, storage for a day's supply of linen and clinical goods. A single workstation will suffice for a group of beds.

3.14 If project teams wish to omit doors to multi bedded rooms they must consult with the local Board's fire advisor and infection control team. Doors can only be omitted where they are not required for fire safety, infection control or acoustic reasons.

3.15 Each multi-bedded room should have easy access to informal social space as the majority of patients, even when highly dependent, are encouraged to leave their beds.

Example layouts of single-bed and multi-bedded rooms are contained in Appendix 1.

Figure 9: Single-bed room and en-suite Hillindon Hospital

(Reproduced with the permission of The Hillingdon Hospital NHS Trust)

Sanitary facilities

Single-bed room en-suite shower room

3.16 Each single-bed room en-suite will have a WC, shower and general washbasin.

For detailed guidance on this en-suite and alternative designs for sanitary facilities, refer to HBN 00-02: 'Sanitary spaces' and SHTM 64: 'Sanitary assemblies'.

Multi bedded room sanitary facilities

3.17 Multi-bed rooms must have en-suite sanitary facilities. Best practice is to provide an assisted shower room (with WC, shower and wash-hand basin) and a separate semi-ambulant WC (with hand-rinse basin), both en-suite to the bedroom area. This allows one person to shower without preventing others from using the WC. However, privacy and dignity should be ensured by the provision of appropriate sound proofing, security devices, locks etc. En-suite doors should not open directly onto adjacent bed areas.

3.18 Appendix 1 provides an example layout for multi bedded room sanitary facilities. For detailed guidance on sanitary facilities for multi bedded rooms, refer to HBN 00-02: 'Sanitary spaces'.

General

3.19 Design teams should consider the provision of motion sensors for lighting in sanitary facilities. If motion sensors are used designers should ensure that the lighting comes up to full illumination without delay and remains on for a suitable length of time. This may help to avoid the problem of fragile patients using sanitary facilities in the dark.

3.20 The wet shower area of the compartment should be separated by a curtain which should extend almost to the floor surface; the remainder of the area will serve as the drying area. There must not be a step between the wet and dry areas. The wet area floor should fall towards the floor outlet with sufficient gradient to ensure proper drainage and prevent ponding or spread of water into the dry area. The floor surface requires to be slip-resistant. Access to other sanitary fittings should not require wheelchairs and patients to cross the graded wet area.

3.21 Help call system cords must be easily identifiable, accessible from the wet area and WC area and descend far enough to be within the reach of a patient who has fallen or collapsed. All pull cords must be cleanable.

3.22 Ventilation should prevent excessive heat, humidity and odours.

3.23 For more detailed guidance on sanitary facility layouts, refer to HBN 00-02: 'Sanitary spaces'.

Assisted bathroom or shower room (Essential complementary accommodation)

3.24 In addition to en-suite facilities, an assisted bathroom and/or shower room is required, although this/these may be shared with adjacent wards. These must have doors suitable to allow patient hoists, wheelchairs and trolleys to access the room.

3.25 Patients using an assisted bathroom or shower room may arrive in a wheelchair or on a shower trolley. Staff assist the patient in bathing/showering and associated activities, and may also give treatments. In bathrooms a variable-height peninsular bath is essential. In both bathrooms and shower rooms there must be sufficient space to accommodate three staff, and to permit the manoeuvring of support equipment such as a hoist. The rooms should also contain a WC and washbasin.

For more detailed guidance refer to HBN 00-02: 'Sanitary spaces'.

Isolation suite (Optional accommodation)

3.26 An isolation suite comprises a single-bed room, en-suite facilities and a ventilated entry lobby.

For detailed guidance on isolation suites and example layouts see SHPN 04 Supplement 1: 'Isolation facilities in acute settings'.

Ceiling hoist track

3.27 Where it is proposed to install a ceiling hoist track system between a bedroom and its en-suite facilities, the design should not compromise the airflow pattern between the two rooms. In isolation rooms the design of the isolation suite works on the principle of supplying air from the lobby at high level to the bedroom and removing it at low level via a transfer grille in the en-suite door. This ensures good mixing of the air in the bedroom, with a consequent dilution of possible contaminants. The wall area above the outward-opening door that is penetrated by the track and suspension system should not therefore allow unrestricted airflow between the bedroom and en-suite at high level. Suitably profiled filler boards and the use of brush seals will ensure an adequate resistance to flow and prevent short-circuiting.

Touchdown bases

3.28 In addition to workstations in bedrooms, space will be required adjacent to, but not within bedrooms, for clinical administration. The touchdown base provides a place for accessing and updating electronic patients records (EPRs) and other computer work. It should only be used for short periods of time. It should be recessed sufficiently from circulation routes so that a member of staff, either standing or perching on a stool, does not cause an obstruction. The base will require power and data points, alarm panel, lamp repeat for drugs cupboard,

task lighting and a computer (security to be considered when the computer is not in use/not manned).

For detailed guidance on touchdown bases see HBN 00-03: 'Clinical and clinical support spaces'.

Figure 10: Touch down base

Patient Support Facilities

3.29 A variety of support facilities are required for patients. For example in refurbishment projects or other projects where multi-bed rooms may be provided there will be a need for separate rooms for treatment, one-to-one discussions, interviews or education.

Treatment room

3.30 Wards with multi-bed rooms will require a treatment room where clinical procedures can be carried out in private. In wards with 100% single-bed rooms, the provision of a treatment room is optional.

3.31 Patients using the treatment room may be ambulant, in a wheelchair, on a trolley or on a bed. The entry door width and the circulation area outside the room must be sufficient to permit the turning and passage of a patient in a bed.

Refer to HBN 00-03: 'Clinical and clinical support spaces' for more detailed guidance.

Interview room

3.32 Discussions with patients and relatives may be carried out in an interview room. This room can also be used by staff for staff interviews, appraisals and counselling. Good acoustic privacy is required, for more information refer to SHTM 2045: 'Acoustics' (to be replaced by SHTM 08-01). Visual privacy must be ensured through the use of blinds or curtains at any windows. Double glazed panels in doors must also be capable of being obscured, preferably with integral blinds.

3.33 The designer should aim to create an environment that is cheerful, comfortable and warm. Appropriate lighting and decorative textures such as pictures and plants can help to provide a pleasant atmosphere. Finishes and furniture will have an important influence on the room. Easy chairs and coffee tables will normally be provided. It is important that rooms in which patients will be sitting are free from draughts. The room must be accessible to wheelchair users, the designers should be informed of any additional requirements.

Refer to HBN 00-03: 'Clinical and clinical support spaces' for more detailed guidance.

Informal social space

3.34 Patients from both single-bed and multi-bed rooms will require informal social spaces. Open yet intimate areas recognisably intended for casual meeting and talking may be all that is required. These spaces will enable patients to socialise without the provision of dedicated day rooms, social spaces should be designed in a way that allows patients in wheelchairs and beds to make use of them. Where day rooms are provided they should be as inviting as possible, with hotel or domestic style furnishing. It should be possible for patients to control environmental features such as lighting. Planning decisions should consider patients' culture and preferences in terms of privacy, modesty and same sex accommodation

Pantry/refreshments area

3.35 The pantry/refreshments area will be equipped with facilities for:

- the preparation of beverages and light snacks;
- potable water supply;
- the storing and filling of patients' water jugs;
- storage of dry goods, and a suitable amount of crockery and cutlery;
- refrigeration of a small quantity of perishable food;
- washing of cutlery and crockery;
- washing hands.

3.36 An industrial-grade mechanical dishwasher is required in order to meet the rinse cycle temperatures required for infection control purposes. Separate facilities for washing-up and hand washing are required. Crockery and cutlery used for main meals will generally be returned to the central washing-up service. There should also be adequate storage for patient jugs.

For further guidance refer to HBN 00-03: 'Clinical and clinical support spaces'.

Regeneration kitchen (Optional accommodation)

3.37 A regeneration kitchen will be required where the local catering policy requires food to be delivered to a department for regeneration and then distributed to a number of wards. The catering contractor should determine the design of the regeneration kitchen. Generally in new build facilities this is likely to serve a number of wards. Waste disposal process will be in accordance with the appropriate hospital policy. Substantial heat gains should be expected within this accommodation.

Parking bay: food trolley

3.38 Each ward will require at least one centrally located bay for parking the food trolley/trolleys while meals are distributed to patients. These bays will require appropriate electrical outlets for the trolleys and they should also be located adjacent to, or close by, suitable hand-washing facilities.

Resuscitation trolley bay

3.39 Emergency equipment - such as the resuscitation trolley which includes a defibrillator, medical gas cylinder and portable suction machine - should be parked in a bay where it is accessible from the bedrooms, but should not obstruct circulation areas and escape routes.

Storage Spaces

3.40 Store rooms can be a costly means of providing storage, as they require internal circulation space. Where storage only requires relatively shallow cupboards it may be more convenient and cost effective to provide cupboard opening directly from circulation areas. The latter is particularly useful for goods for which stocks are maintained by an exchange trolley service. If cupboards require to be recessed so that the open doors do not obstruct movement in the corridor then the potential saving in circulation space may be lost.

Clean supply room (Essential complementary accommodation)

3.41 This room provides storage for sterile supplies and consumables for a number of wards. Supplies trolleys are brought here for restocking. See HBN 00-03: 'Clinical and clinical support spaces'.

Clinical supplies trolley

3.42 Clean and sterile goods for daily use will be held on trolleys, usually kept at the point of use in bedrooms under worktops or workstations.

Large equipment store

3.43 This store is required for bulky items of equipment, bed accessories and therapy aids. Open shelving, hanging rails and hooks as well as freestanding space for heavy equipment such as hoists and weighing machines are required. Sockets will be required for equipment that needs charging. Disposable items delivered in bulk packages to the clinical area will require storage.

3.44 Design teams may decide that more than one large equipment store is required. A number of local stores adjacent to single-bed rooms or four bedded rooms may be more efficient.

Linen store

3.45 For infection control purposes, clean linen will be kept in a closed store rather than on trolleys in an open bay. Local policy will determine whether linen is stored in single-bed rooms or in a central store, storage of linen in single-bed rooms can improve staff efficiency.

Utilities

Preparation room and Medicine store

3.46 The preparation room/medicine store is required for the storage and preparation of all the medicines to be used on the ward. This will include controlled drugs, medicines requiring refrigeration, and consumables such as syringes and needles. Rechargeable syringe drivers and infusers may be stored here.

See HBN 00-03: ‘Clinical and clinical support spaces’ for more detailed guidance.

Dirty utility room

3.47 The dirty utility room serves as the temporary storage point and testing area for urine specimens. It also contains equipment for the destruction of disposable bedpans or cleansing of non-disposable bedpans etc. Such equipment may generate significant noise levels so care should be taken to eliminate or contain this. Suitable space will be required for all the sack holders for the colour-coded disposal bags used for the bagging of waste materials and dirty linen skips. If clinical waste is stored here the room must be secured/lockable.

See HBN 00-03: ‘Clinical and clinical support spaces’ for more detailed guidance.

Cleaners' Room/Domestic Service Room (DSR)

3.48 The cleaners' room is the base from which domestic service staff will provide the immediate day-to-day cleaning service. Care must be taken to ensure that the room is large enough to hold, store and park all the required fittings, equipment, storage cupboards and shelves. Fittings will include stainless steel sink, low level bucket sink and separate hand washing facilities.

See HBN 00-03: 'Clinical and clinical support spaces' for more detailed guidance.

Disposal hold

3.49 The disposal hold provides the temporary storage point for all items of supplies and equipment that have to be removed for cleaning, reprocessing, disposal or destruction. Materials include clinical and non-clinical waste and also items to be transferred to the sterile services department.

3.50 The disposal of waste and used items must be consistent with the current hospital policy for the disposal of clinical waste.

See HBN 00-03: 'Clinical and clinical support spaces' for more detailed guidance.

Switchgear cupboard

3.51 A departmental switchgear cupboard housing the main isolators and distribution switchgear must be:

- accessible directly from the circulation area (access space may be part of the circulation area);
- sited away from water services and overhead drainage pipework;
- lockable.

3.52 Where possible, the cupboard should be sited within the department, usually adjacent to the main entrance. There must be clear and safe access for maintenance staff. Care must also be taken to ensure that safety is not compromised during maintenance, from passing traffic or the opening of adjacent doors.

Administration Areas and Staff Facilities

Reception and waiting area (Essential complementary accommodation)

3.53 The reception desk should be located in a prominent position at the main entrance to the ward. The counter needs to be stepped so that a person in a wheelchair can see and speak easily to the receptionist. The desk requires sufficient working space for a receptionist and one other who will welcome patients, relatives, visitors and staff. They will also undertake the local clerical

and administrative duties. Adjacent wards may share the reception desk and waiting area.

Figure 11: Reception desk, Altnagelvin area hospital

(Reproduced with the permission of HLM Architects – photographer Christopher Hill)

3.54 The reception desk will be linked by computer to all areas. Space is required for at least one computer terminal and associated equipment, including a printer. The reception desk should be designed to allow surveillance of all entrances, waiting areas and corridors leading to treatment rooms. CCTV should be installed to enable monitoring of all entrances, reception and waiting areas. Alarms from Area Valve Service Units (AVSUs) for piped medical gases should be installed here.

3.55 A seated area should be provided near the reception desk for patients, relatives and visitors waiting to be received. Access to visitors' WCs, nappy change facilities and vending machines is required. The waiting area may also serve as additional informal day space for patients.

Office/meeting room

3.56 This office is a multi-purpose office, but is likely to be used principally by clinical staff to complete notes on discharged patients, hold patient handover meetings, make telephone calls and for staff discussions.

3.57 Ideally it will be located close to bed areas and sized to accommodate two computer workstations, a table and eight to ten people. A cupboard or shelves for storing a limited amount of stationery will be required.

Generally there will be no separate medical staff or ward manager's office.

Staff locker bay

3.58 Staff will require local security lockers to hold small personal belongings while on duty. It may be convenient to locate lockers within or adjacent to the staff rest room/beverage bay where provided or within lobbies to staff toilets.

In wards that contain staff changing facilities, staff will have easy access to the lockers in the changing rooms and a separate locker bay will not be necessary.

Staff WC

3.59 A WC is required for clinical staff working on the ward. In wards that contain staff changing facilities, staff will have easy access to sanitary facilities and a separate WC will not be necessary.

Staff changing room (Essential complementary accommodation)

3.60 Facilities are required for staff changing, clothes storage, showers and sanitary facilities. These facilities may be shared between several wards or may be centrally located and serve the whole hospital. Calculations for the required amount of changing space and locker provision should take into account the numbers of full-time and part-time staff, including trainees and students.

3.61 Separate changing rooms for males and females will be required, each with their own shower rooms, WCs, shaving point, power points for hair dryers and a large well-illuminated mirror with a shelf. The sanitary (WC and WHB) and shower facilities will be within self-contained rooms with full-height partitions providing maximum privacy. The provision of rows of cubicles is not an acceptable alternative.

3.62 Access control should be fitted to all staff changing and sanitary facilities.

See HBN 00-03: ‘Clinical and clinical support spaces’ for more detailed guidance.

Staff rest room (Essential complementary accommodation)

3.63 Rest room facilities are required where staff can relax and take beverages. These may be shared between several adjacent wards. Rest rooms should have windows of a suitable size to provide an acceptable level of daylight together with a pleasant outlook. The room should be suitably and comfortably furnished.

3.64 The rest room will include a beverage bay with facilities to allow staff to prepare beverages, wash and store crockery and cutlery. It should also provide storage for a limited quantity of dry goods and for the refrigerated storage of milk etc.

See HBN 00-03: ‘Clinical and clinical support spaces’ for more detailed guidance.

Seminar room (Essential complementary accommodation)

3.65 It is assumed that a designated education centre with conference facilities for multi-disciplinary use will be available on site.

4. General engineering and environmental principles

Introduction

4.1 This section provides general guidance on the engineering, technical and environmental aspects of healthcare building design. Specific guidance in relation to in-patient facilities for adults is shown in **bold**.

4.2 Consultation should take place at project and design team levels to ensure the understanding of key issues, healthcare delivery and the appropriate standards for healthcare engineering services.

4.3 Designers should ensure that they read this publication as a whole since further engineering guidance may be outlined in, and cross-referenced within, other sections.

4.4 The engineering Scottish Health Technical Memorandum (SHTM) series is supported by the overarching publication SHTM 00: 'Best practice guidance for healthcare engineering - Policies and Principles' which covers the following issues:

- overview of engineering services guidance;
- statutory and legislative requirements;
- professional support;
- operational policy;
- training and workforce development;
- emergency procedures and contingency planning;
- training, information and communications;
- maintenance;
- engineering services.

4.5 Guidance on specific types of engineering services can be found within the SHTM series of documents that are listed within the References appendix.

Space requirements for services and plant

4.6 A high level of availability of engineering plant and services is critical to the ability of the facility to function safely and efficiently. It is therefore essential that the building design incorporates adequate space for the full range of building services and the requirements for installation and maintenance of plant, ductwork, pipework and cabling.

4.7 Space for plant and services must provide:

- easy and safe means of access for personnel and equipment ;
- secure accommodation protected from unauthorised access;
- adequate space around the plant services to permit full and safe inspection, maintenance and replacement.

4.8 Guidance on spatial requirements for engineering plant and services is contained within the SHTM guidance documents for healthcare engineering. Further useful information regarding the provision of space for plant is contained in BSRIA Technical Note TN 9/92, and for building services distribution systems in BSRIA Technical Note TN 10/92.

4.9 With the exception of drainage and some heating pipework, engineering services must not be brought up from the above-ceiling space of a floor below. Service distribution to a particular area should generally be contained within service spaces on that floor.

4.10 Plant rooms, particularly for temperature cooling and ventilation, will be located as close as possible to the areas they serve, thus minimising the amount of space necessary to accommodate large ducts.

4.11 Care should be taken to ensure that noise and structure-borne vibration is not transmitted beyond the plant rooms. Further guidance on acoustics and vibration can be found in SHTM 2045: ‘Acoustics’, 2001 (to be replaced by SHTM 08-01: ‘Acoustics’).

Decontamination

4.12 Decontamination is the combination of cleaning, disinfection and sterilization used to render a re-usable item safe for further use on patients and handling by staff. The effective decontamination of re-usable surgical instruments is essential in minimising the risk of transmission of infectious agents. Sterilization and decontamination guidance is available on the HFS website (http://www.hfs.scot.nhs.uk/).

Mechanical services

Piped medical gases

4.13 Piped medical gases should be designed in accordance with the requirements of SHTM 2022: ‘Medical gas pipeline systems’ (to be replaced by SHTM 02-01).

Heating

4.14 General space heating requirements may be met by a variety of systems including radiators, radiant panels or within the ventilation system. Designers

should ensure that the most appropriate method is employed with for the healthcare environment being provided.

4.15 Where heat emitters are used and are accessible to touch the surface temperature must not exceed 43ºC. Exposed heating pipework accessible to touch must be encased and/or insulated. Further information is given in SHGN 'Safe hot water and surface temperatures' (to be replaced by SHTM 04-01). Particular care should be taken when providing systems within facilities for elderly and mental health. Where radiators are encased/covered these require to be secured in a way that allows the cover to be easily removed by cleaners without the need of technical assistance.

Care should be taken to ensure that heat emitters do not adversely affect the local temperature conditions of adjacent storage and preparation areas.

4.16 When radiators are installed they should be located under windows or against exposed walls. There should be space between the top of the radiator and the windowsill to prevent curtains reducing the output. There should also be adequate space underneath to allow cleaning equipment to be used easily and correctly.

4.17 Where appropriate, heating controls should be provided to modulate heating circuit flow temperatures in accordance with external temperature. Radiators or radiant panels may also be used to offset building fabric heat losses in mechanically ventilated spaces. The system should be designed to ensure that the heating and ventilation systems operate in a coordinated manner and do not cause the space to overheat. Heat emitters in single-bed rooms should be provided with controls operated from the bedhead so that patients can adjust the room temperature.

4.18 Ceiling-mounted heating panels can operate at higher temperatures than 43°C as long as the surface temperature is not easily accessible. Panels should not be located over beds, patient trolley positions, or in other locations where they might radiate directly onto a patient or member of staff for a prolonged period. In new construction complying with the latest Building Regulations, heat losses are sufficiently low so as to allow a modular approach to be adopted for panel selection, thereby allowing them to fit into the ceiling grid pattern. In refurbishment projects where this does not apply, panels should be kept as narrow as practical and routed around the perimeter of rooms.

All ceiling panels should be selected to match aesthetically the adjacent ceiling and should be sealed to it by means of a gasket or similar.

Ventilation

4.19 For areas where it is absolutely necessary to install mechanical ventilation, the systems should be designed in accordance with the requirements of SHTM 2025: 'Ventilation in healthcare premises' (to be replaced by SHTM 03-01).

4.20 Air movement induced by mechanical ventilation will be from clean to dirty areas, where these areas can be defined. The design should allow for adequate flow of air into any spaces having only mechanical extract ventilation. This can be achieved via transfer grilles in doors or walls. However, such arrangements should avoid the introduction of untempered air and also must not prejudice fire safety, acoustic requirements or privacy.

4.21 Local exhaust ventilation (LEV) will be required where exposure (by inhalation) to substances hazardous to health cannot be controlled by other means. The Health and Safety Executive publishes guidance notes, updated annually, on occupational exposure limits (Guidance Note EH40 – 'Occupational Exposure Limits') for the control of exposure by inhalation of substances hazardous to health. The limits specified form part of the requirements of compliance with the Control of Substances Hazardous to Health Regulations 2002 (COSHH).

Further guidance on the design of LEV systems may be found in SHTM 2025 (to be replaced by SHTM 03-01).

Hot and cold water systems

4.22 Hot and cold water storage and distribution systems should be designed in accordance with the requirements of SHTM 2040: 'The control of *Legionella* in healthcare premises - a code of practice and SHGN 'Safe' hot water and surface temperatures' (both being replaced by or incorporated within SHTM 04-01 parts A & B).

Automatic water conserving taps operated by proximity detectors should be used where possible, where provided these should be powered from the mains (with backup) and not battery powered. It is also advantageous if fault detection and warning systems are fitted. In locations where basins may not be used for long periods of time consideration should be given to installing automatic systems that will periodically run taps for flushing of *Legionella*. The system should be able to provide evidence for recording.

Further information will be contained in SHTM 04-01.

4.23 Exposed hot-water pipework accessible to touch must be encased and/or insulated. Special care should also be taken when facilities are being provided for older, confused or mental health patients.

Building management systems

4.24 All engineering plant and equipment associated with the internal environment should be controlled, monitored and regulated by a building management system (BMS) in accordance with the provisions of SHTM 2005: 'Building management systems'.

4.25 Requirements for the monitoring and control of plant and systems are also covered in the SHTMs that relate to the particular plant or system.

Internal drainage

4.26 A system of soil and waste drainage including anti-siphon and ventilation pipework should be provided in accordance with BS EN 12056.

4.27 Where plastic pipework materials are used, apart from some small diameter pipes, suitable intumescent collars require to be fitted when breaching fire compartments. Acoustic wrapping should be applied where drainage runs above wards and other sensitive areas.

4.28 The gradient of branch drains should be uniform and adequate to convey the maximum discharge to the stack without blockage. Practical considerations such as available angles of bends, junctions and their assembly, space constraints will normally limit the gradient to about 1:50 (20mm/m).

4.29 For larger pipes, for example 100mm in diameter, the gradient may be less but this will require high quality workmanship if an adequate self-cleaning flow is to be maintained. **Bedpan washers or macerators should discharge with a short branch to a vertical stack or horizontal drain. The waste pipe should not be installed above or close to heating or hot water mains. If a bedpan washer or macerator discharges to a 100mm drain, frequently used large-volume appliances should be situated upstream of its connection to provide additional flushing. The manufacturers' technical guidance should be followed when determining the location of washers and distance from vertical stacks.**

4.30 Provision for inspection, rodding and maintenance should ensure 'full bore' access; also these inspection points should be located outside user accommodation. The location of manholes within the building is to be avoided.

4.31 To prevent the ingress of bacteria, waste outlets from distillation plant and refrigerators should be connected outside of the department, should not be directly connected to the drainage system and should discharge via a trapped tundish or gully.

4.32 Drainage/waste systems from cooling units should be installed to prevent Legionnaires' disease and other bacteria back-feeding.

Acoustics

4.33 Consideration should be given at the earliest opportunity to the requirements for privacy and the impact of any intrusive noise that may affect the function of the healthcare facility. Guidance in relation to functional relationships is given in SHTM 2045: 'Acoustics' (to be replaced by SHTM 08-01).

4.34 Acoustic design is fundamental to the quality of healthcare buildings. Sound affects us both physiologically and psychologically. Noise, which can be defined as 'unwanted sound', can increase heart rate, blood pressure, respiration rate and even blood cholesterol levels. Pleasant sounds help create a sense of well being. Music can be used to treat depression, to reach autistic people and to calm and relax tense patients.

4.35 Good acoustic conditions improve patient privacy and dignity, and promote essential sleep patterns. Such conditions are key to healing. Good acoustic design brings other benefits in terms of patient and staff comfort and morale, as well as improved efficiency and usability of equipment.

4.36 SHTM 08-01: 'Acoustics' will cover the acoustic design criteria that are important for healthcare premises, and will address issues such as the provision of temporary healthcare facilities, refurbishments and the control of noise and vibration during construction.

4.37 Consultation with a specialist acoustic adviser should be considered. Detailed acoustic theory is not included in SHTM 08-01, although sufficient detail is given for a basic understanding of the acoustic issues. It would be unwise to design a healthcare development without specialist acoustic advice from the outline design stage.

4.38 Guidance in relation to functional relationships is currently given in SHTM 2045: 'Acoustics' (to be replaced by SHTM 08-01).

Fire safety

4.39 Fire safety standards in healthcare premises require to be high due to the vulnerability of occupants. The policy in respect of fire safety is set out in NHSScotland Firecode suite of documents including Fire Policy for NHSScotland, CEL (2008) 25. The design team must satisfy itself that the design meets the objectives of this guidance or provide a fire engineered solution that achieves at least the same minimum objectives and requirements. Guidance on fire engineering for NHSScotland is provided in Firecode SHTM 81: Part 2 'Guidance on the fire engineering of healthcare premises'.

4.40 It is critical to establish during the design stage those aspects of fire strategy that may affect the planning of a project. At appropriate stages of the design process, the appropriate design team members must discuss their proposals with the relevant Board fire safety advisor and the Building Control Authority and they should also ensure that the Project team and all other design/planning staff are fully acquainted with the fire strategy for the design. This will include equipment provision, building and engineering layouts and will assist the Client/Board with operational aspects, staff responsibilities etc.

Fire detection and control systems

4.41 Fire detection, alarm and control systems are an integral part of the overall fire plan for a building. Fire alarm provisions for in-patient facilities are based on the principle of phased evacuation to support the provision of progressive horizontal evacuation. Measures to limit and mitigate the effects of unwanted fire signals due to fire alarm and detection systems are a significant imperative and specific guidance on this issue is contained in NHSScotland Firecode SFPN 11: 'Reducing unwanted fire signals in healthcare premises'. For these reasons it is recommended that the Board Fire Safety Advisor is consulted with regard to the

design of the fire alarm and detection system. Close co-ordination between the architect and design engineers is essential to ensure that compartmentation, high-risk processes, dangerous goods and other fire-related risk issues are fully understood and embraced in the fire management solution.

A copy of the current NHSScotland Firecode suite of documents should be provided by the NHSScotland Board in accordance with the requirement specified in SHTM 81: Part 1 'Fire precautions in new healthcare premises', paragraph 1.9a.

For guidance see NHSScotland Firecode suite of documents (SHTMs and SFPNs) available at www.hfs.scot.nhs.uk/ or contact HFS at nss.hfsenquiries@nhs.net.

Electrical services

General

4.42 Electrical installations must comply with the current edition of BS 7671 IEE Wiring Regulations together with Guidance Note 7 (Special Locations) and relevant SHTMs for electrical services. See also 'Medical Electrical Installation Guidance Notes' (MEIGaN; MHRA).

4.43 Prior to final design, a full assessment must be made of the risk, function, occupation, equipment and resilience requirements for the area. This will influence the extent and location of services, the availability of alternative electrical supply distribution and the need for local standby supplies if appropriate.

Electromagnetic compatibility

4.44 Care should be taken to avoid mains-borne and electrical radio frequency interference affecting diagnostic and monitoring equipment, computers or other sensitive electronic equipment. Guidance on the avoidance and abatement of electrical interference is given in SHTM 2014: 'Abatement of electrical interference' (to be replaced by SHTM 06-01).

Main intake switchgear and distribution boards

4.45 The main electrical supply should be part of the whole site/building network, and must provide adequate capacity for both normal and all assessed business-critical needs.

4.46 Main intake and distribution equipment will be sited away from patient areas and areas where access would disrupt normal communication routes.

4.47 Careful consideration must also be given to the impact from flooding, pipework leaks and mechanical damage.

Emergency electrical supplies

4.48 Emergency electrical provision should comply with the requirements of SHTM 2011 'Emergency Electrical Services' (to be replaced by SHTM 06-01).

Small power distribution systems

4.49 Depending upon the capacity of the emergency generator installation and risk assessment (see paragraphs 4.45 – 4.47 above), it may be appropriate to provide separate essential and non-essential small power distribution systems.

4.50 Adequate provision should be made in circulation areas, for example corridors and lobbies, to allow the use of domestic cleaning equipment having flexible cords up to 9m long.

Lighting systems

4.51 Lighting services, including lighting controls should comply with CIBSE 'Code for Lighting'; Guide LG2: 'Hospitals and Health Care Buildings'; and Guide F: 'Energy Efficiency in Buildings'. Also see SHTM 2015: 'Bedhead services' (to be replaced by SHTM 08-03).

4.52 In areas where VDUs are in use, lighting must be designed to comply with the guidance given in CIBSE Guide LG7: 'Office lighting'.

To achieve energy efficiency, lighting systems will be designed to:

- maximise use of natural daylight;
- avoid unnecessarily high levels of illumination;
- incorporate efficient luminaires, control gear and lamps;
- incorporate effective controls.

4.53 Lighting and the appearance of luminaires should be coordinated with architectural design. In particular collaboration is required to ensure that decorative finishes are compatible with the colour-rendering properties of lamps and that the spectral distribution of the light source is not adversely affected. See also 'Lighting and colour for hospital design – a report on an NHS funded research project' (Dalke et al, 2004). Refer to CIBSE 'Code for Lighting' for minimum recommended daylight factors.

4.54 Light switches should be provided in easily accessible positions for all uses of the facilities and at appropriate locations in corridors and general circulation areas. In areas with multiple luminaires, switches should permit the selection of luminaires appropriate to the area requiring illumination.

4.55 Where local circumstances permit, the provision of time switches or occupancy controls using infrared, acoustic or ultrasonic detectors should be encouraged. Additionally, low energy or ultra-low energy lighting should be considered as the primary lighting source.

4.56 Safety escape lighting must be provided on primary escape routes in accordance with the provisions of SHTM 2011 'Emergency Electrical Services' (to be replaced by SHTM 06-01), SBSA Technical handbooks, NHSScotland Firecode and the CIBSE Lighting Guide LG2 – 'Hospitals and Health Care Buildings'.

4.57 It is essential that fluorescent lighting in all areas where medicines or containers are processed, including stores, be derived from lamps having suitable colour-rendering characteristics.

Help call systems

4.58 Help call systems should comply with the requirements of SHTM 2015: 'Bedhead services' (to be replaced by SHTM 08-03).

4.59 Patient/staff call points should be provided in all spaces where a patient/attendee may be left alone temporarily – for example consulting, examination and treatment rooms and WCs.

4.60 Staff emergency call points are for a member of staff to call for assistance from another member of staff. They should be provided in all spaces where staff consult, examine and treat attendees/patients. Call facilities may also be provided on hand-held devices.

4.61 The help call systems may be hard-wired, secure wireless or secure radio systems.

4.62 Where considered necessary, staff crash call points may be specifically provided for members of staff to call the crash team. This is not required as a standard installation, and needs to be specified for individual rooms where the patient is at high risk of suffering a cardiac arrest.

4.63 A visual and audible indication of the operation of each system should be provided to give responding staff unambiguous identification of the call source, with a repeater unit in a suitable location.

Security

4.64 Measures should be incorporated in the design of all NHS buildings to help protect the safety of staff, patients and visitors and the security of the premises. Security systems will require a local risk assessment and crime prevention survey to be carried out for both daytime and out of hours. Systems will include swipe cards, smart cards, CCTV, panic alarms and other available technological solutions. The project team should discuss security with the local police crime prevention officer and the Board's nominated local security management specialist (LSMS) at an early stage in the design process. Also see SHTM 2015: 'Bedhead services' (to be replaced by SHTM 08-03).

The local fire officer and LSMS should be consulted concurrently to avoid the possibility of the demands of security and fire safety conflicting.

IT and telephone wiring systems

4.65 The IT and telephone infrastructure within the facility may be determined by existing systems within the building. However, where possible, a structured wiring system as described in Heath Guidance Note 'Structured cabling for IT systems' should be provided. This will permit a unified approach to the provision of cabling for:

- voice systems;
- data systems;
- imaging systems;
- alarm systems.

4.66 While this 'universal' cabling system is initially more expensive than separate voice and data systems, the long-term cost of ownership should prove beneficial.

4.67 In determining the nature of the IT system to be provided, it is necessary to identify:

- areas to be served;
- whether structured cabling will be used;
- what density of outlets is to be provided (not fewer than two per workstation);
- whether wiring will be on a 'flood' or 'as required' basis.

Bedhead services and entertainment systems

4.68 Allowance should be made for the introduction of television and radio systems to create a relaxing atmosphere in waiting areas, staff rest areas and in locations where it will be beneficial in masking sound transfer.

Other services will be provided in accordance with SHTM 2015: 'Bedhead services'.

Pneumatic tube transport systems

4.69 If a pneumatic tube system is to be installed, investigation should be undertaken to ensure that the system will meet the needs of the whole, or the required part, of the hospital site. Careful consideration should be given by the Client and end users regarding the siting and orientation of all 'stations'. For further guidance on the design of pneumatic tube systems, see SHTM 2009 'Pneumatic air tube transport systems'.

Lifts

4.70 For buildings other than single storey lifts will be required in order to comply with the requirements of the Disability Discrimination Act (DDA), which is to be replaced by the Equality Act in late 2010,and the Scottish Building Regulations. Separation between clinical, visitor and FM clean and dirty flows is important in vertical circulation. For further guidance on the design of lift installations, see SHTM 2024 and HBN 00-04: ‘Circulation and communication spaces’.

Controlled Drugs storage

4.71 Controlled Drugs cupboards within wards or clinical areas must be fitted with a red lamp indicating when the cupboard is unlocked. A repeater lamp should be sited outside the doorway of the room in which the cupboard is located. If appropriate a secondary repeater should be taken to a permanently staffed station.

4.72 The normal power supply for each cupboard must be backed up by an integral battery to cover the period between mains failure and the generator becoming available.

4.73 To assist in keeping their contents secure, controlled drugs cupboards will be fitted with a seven-lever mortice lock designed to meet BS 3621.

Sustainability and energy efficiency

4.74 The environment in which people live and work has a key influence on their health and the Scottish Government Health Directorates have required that all NHSScotland Bodies engaged in the procurement of both new-build and refurbishment of healthcare buildings must carry out independent environmental accreditation for projects. The Scottish Capital Investment Manual requires that all new builds above £2m obtain a BREEAM Healthcare (or equivalent) 'Excellent' rating and all refurbishments above £2m obtain a 'Very Good' rating. If the capital costs are less than £2m, projects should undertake a BREEAM pre-assessment to establish whether BREEAM Healthcare is a viable option.

Attaining the required BREEAM rating will ensure that environmental considerations are taken into account when designing new buildings or adapting existing facilities.

Areas that are considered as being of particular importance are:

- building orientation;
- natural daylighting;
- natural ventilation;
- night set-back;
- building regulations;

- heat recovery;
- water conservation;
- control systems; and
- control of solar gain.

4.75 Efforts should be made to maximise the use of natural lighting. Passive solar design (PSD) should be employed as far as possible to ensure that areas such as wards, recovery units and offices are located where they can benefit from natural daylight. Other areas including stores, WCs, utility rooms, etc. can be located towards the core of the facility.

4.76 Areas where glare may be a problem, for example where VDUs are routinely used, should be designed to avoid direct sunlight affecting monitors.

4.77 Where appropriate and possible, natural ventilation of rooms should be employed. Design should incorporate measures for minimising solar heat gains, which, if controlled properly, will avoid the need for mechanical ventilation. Measures to minimise the need for cooling may include locating temperature-sensitive accommodation away from south-facing fascias and shading windows.

4.78 Energy consuming systems including heating, ventilation, cooling and lighting should be controlled to minimise consumption. Consideration may be given to utilising the thermal properties of the building when the facility is not in use, for example at night or weekends.

4.79 Energy recovery systems should be employed when possible, and particularly on ventilation systems.

4.80 For further guidance on sustainability and energy efficiency, see HTM 07-02 ‘Encode: making energy work in healthcare’.

Commissioning and maintenance

4.81 On completion of an installation and prior to hand-over it is important that the engineering services and equipment are fully commissioned to validate their function and achievement of performance, including load testing any cooling systems that are installed.

4.82 The final acceptable performance details should be recorded and, together with full manufacturers’ details, made available to users and the maintenance organisation before the facilities are handed over.

4.83 When full operational conditions are achieved, once the facilities are operational, the overall performance should again be performance tested to check that the interface between systems has not been compromised and that the systems operate to the designed criteria.

4.84 Risk management, operational procedures and contingency plans should be fully evaluated with staff to ensure that, in the event of an emergency,

procedures can be put in place to maximise the safety of patients, staff and visitors. In order that staff continue to be fully conversant with what is required of them every opportunity should be taken to practise these procedures when it is safe to do so.

5. Schedules of Accommodation

Introduction

5.1 For all types of health building, it is important that building costs and revenue expenditure achieve best value consistent with acceptable standards.

5.2 In applying this guidance, the need for economy should be of prime concern. Where appropriate, space should be shared between similar activities taking place at different times. However, this solution should not be detrimental to the proper functioning of the spaces involved, nor to the needs of users.

Schedules of accommodation

5.3 Standard schedules of accommodation can be found on the Space for Health website http://www.spaceforhealth.nhs.uk/ under 'Spaces and Costs'. These have adopted a modular approach to the planning of appropriate units to enable project teams to 'pick and mix' those facilities that are required.

5.4 Using this modular approach, notional examples have been built up. The areas given are for guide purposes only and will alter depending on the design solution. The DH Departmental Cost Allowance Guides (DCAGs), for use in England, have been calculated using the example units as a cost base.

5.5 Percentage allowances covering planning, engineering and circulation are also included in the totals.

5.6 The schedules of accommodation show a notional whole department, which highlights the scope for sharing accommodation. The examples are not to be taken as ideal provision for any particular project.

The examples are as follows:

- 24-bed ward, 50% single-bed rooms;
- 24-bed ward, 80% single-bed rooms;
- 24-bed ward, 100% single-bed rooms.

5.7 The schedules of accommodation for HBN 04-01 may be updated from time to time. For the latest version always check the schedule of accommodation database on Space for Health (www.spaceforhealth.nhs.uk).

Dimensions and areas

5.8 The critical dimensions of an area are determined by the spatial requirements of any activities to be carried out within it. Space requirements for various generic

activities appear in HBN 00-02: ‘Sanitary spaces’, HBN 00-03: ‘Clinical and clinical support spaces’ and HBN 00-04: ‘Circulation and communication spaces’

5.9 Planning teams should have data available at the earliest stages of a project to enable the approximate assessment of sizes involved. Areas used for the purpose of establishing cost allowances are listed in the schedules of accommodation. These areas do not represent recommended sizes and should not be regarded as specific individual entitlements.

5.10 The efficient planning of a building may necessitate a variation to the areas given. For example, in the refurbishment/conversion of older property:

- rooms tend to be larger than the areas given;
- some rooms may be too small or in the wrong location for efficient use;
- circulation space tends to form a larger than normal proportion of the total area.

Circulation spaces

5.11 All internal corridors, small vertical ducts, spaces occupied by partitions/walls and other space for circulation, are costed in the DCAGs. Provision is also made for a 5% planning zone and 3% engineering zone adjacent to the external walls.

5.12 Circulation figures included in the DCAGs are those anticipated for new build facilities. Where constraints are encountered, for example in refurbishment or conversion of older types of property, this figure may increase.

Communication spaces

5.13 Hospital ‘streets’, staircases and lifts (linking spaces between ‘departments’) are not included in the schedules.

Figure 12 illustrates typical room, circulation and communication spaces.

Rules of measurement diagram

The **Net Floor Areas** of the rooms or spaces is defined by the green and blue shaded blocks. The departmental circulation is defined by light yellow shading.

The **Net Floor Area** of Department A comprises the sum of the **Net Floor Areas** of Rooms A1, A2, A4 and A5 and Space A3.

The **Gross Floor Area** of Department A is the area within the red line, and Department B within the green line. Plant areas are defined with grey shading.

Communication is circulation between departments. Count stair and lift areas at every level.

Figure 12: Diagram indicating communication, circulation and net floor areas.

(Reproduced by permission of Keppiedesign)

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Appendix 1: Example bedroom layouts

Introduction

Single-bed room

The layout for a single-bed room in this Appendix is an example only. Its purpose is to illustrate how the different elements of the room; bed space, en-suite, clinical support zone, and family zone can be brought together. Other configurations are possible.

In the design of the example layout, the following issues have been considered:

- clear space around the bed (3.6m × 3.7m);
- position of the en-suite shower room;
- bedroom door width into the room;
- location of the clinical wash-hand basin;
- provision of storage and clinical support facilities
- provision of space for a fold down bed or reciner;
- sightlines from touch down base and corridor (at the doorway).

It is assumed that conventional bedhead services are used, although the use of ceiling or wall mounted pendant fittings is possible.

The en-suite - comprising WC, wash-basin and shower – is shown with a chamfered profile. For a rectangular layout, refer to HBN 00-02: ‘Sanitary spaces’.

The location of the en-suite can have a significant impact on the bedroom in terms of floor area, views to and from the bed, external views and support facilities such as the touchdown base. Four layouts, each showing a different location for the en-suite, have been included for illustrative purposes.

Multi-bed room

The layout for a multi-bed room is an example only. It shows a four bedded room with an assisted shower room and a second semi-ambulant WC, both being en-suite. Full details of these en-suite facilities are contained in HBN 00-02: ‘Sanitary spaces’.

An en-suite with fully opening wall cannot be used in this layout because of the loss of privacy in a multiple occupancy room. Each en-suite has an outward-opening single leaf door.

The two en-suites are located inboard, forming a recess at the entrance to the bed areas, providing some privacy to the bed areas.

Two clinical wash-hand basins are located centrally, one next to the room entrance and the other on the outside wall. There is room for one clinical workstation.

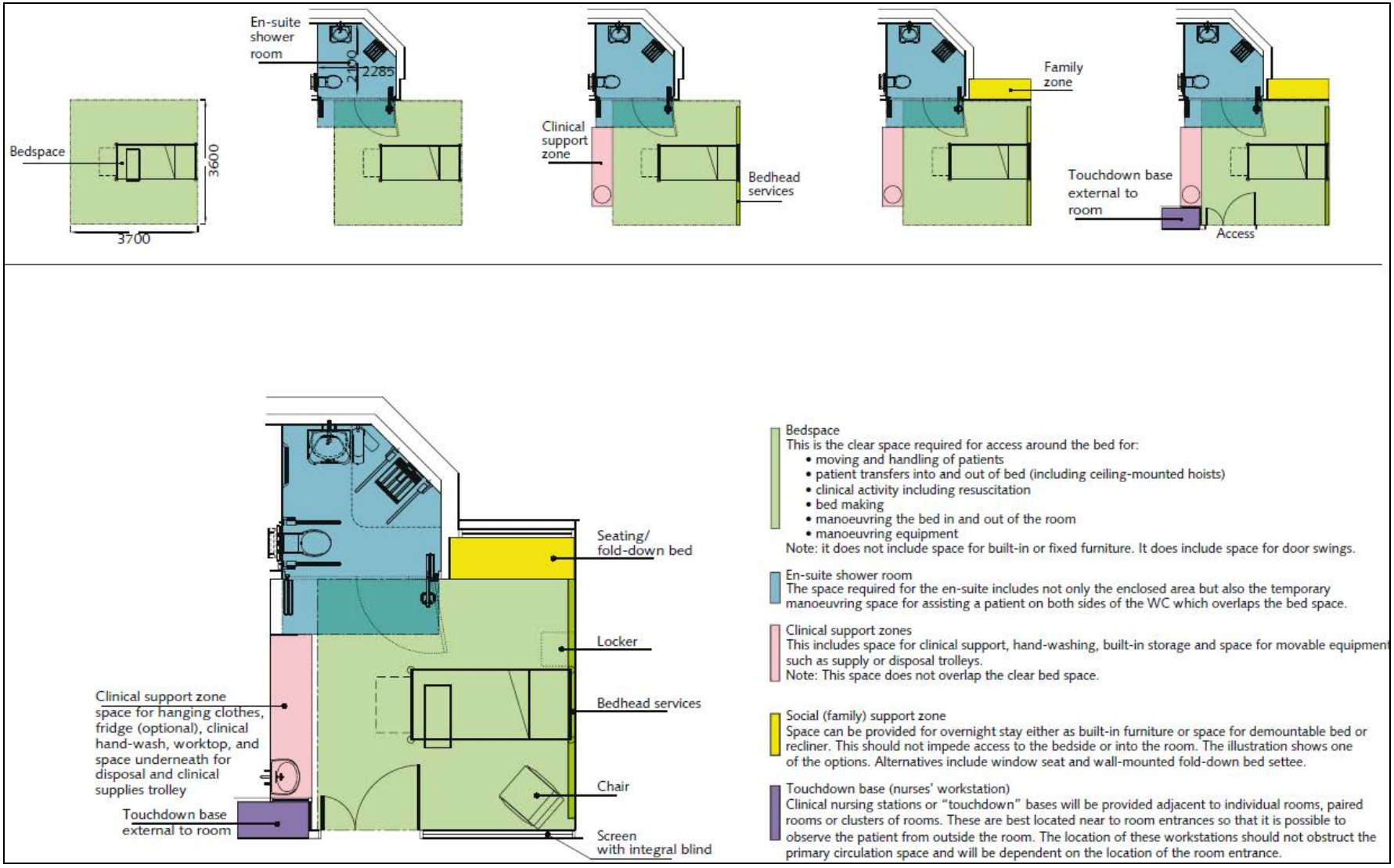
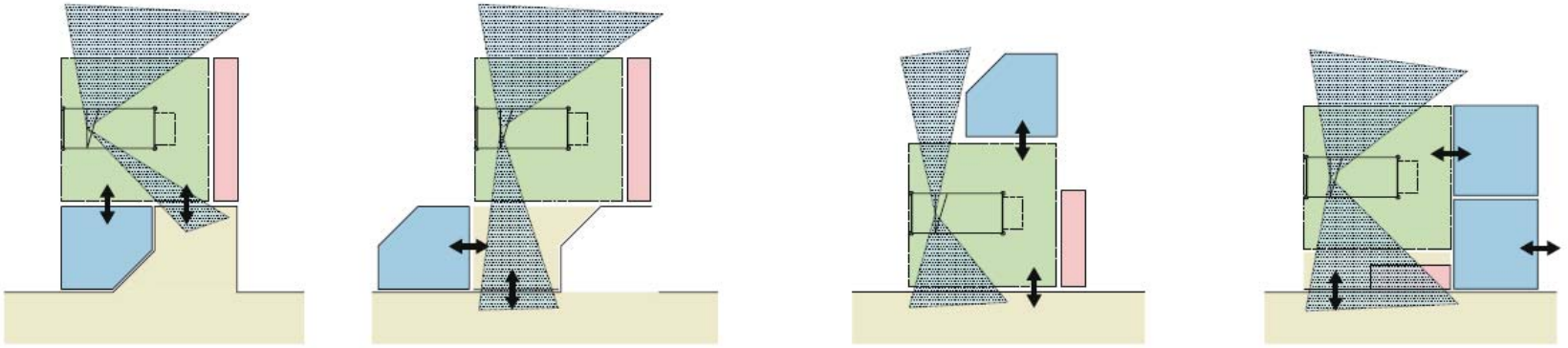


Figure 13: Example layout for a single-bed room

The location of the en-suite has a major influence on the subject room in terms of:

- Access points
- Support facilities including the nurse "touchdown" base
- Views to and from the bed
- Privacy
- Floor area

Views from the bed
En-suite
Bed space
Clinical support
Circulation/corridor space
Access points



Internal en-suite

a) Access to en-suite and to the room are on the same side and this determines the minimum width of the room.
b) Views of the bed from the corridor are restricted.
c) External views are maximised.
d) Privacy for the patient is maximised especially for views into the en-suite.
e) There are two options for support services: external wall or partition wall.
f) Bed turning can be accommodated adjacent to the bedroom, which increases the circulation space but minimises corridor width.
g) The door position can be optimised to increase or decrease space within the room.
h) A nurse "touchdown" base can be accommodated adjacent to the bedroom door.

Internal adjacent en-suite

a) Access to en-suite and to the room are on the same side and this determines the minimum width of the room.
b) Views of the bed from the corridor are improved in comparison to the inboard option.
c) External views are maximised.
d) Privacy for the patient is reduced. Entry to the en-suite can be seen from the corridor.
e) There are two options for support services: external wall or partition wall.
f) To accommodate bed turning, either the corridor or the bedroom doors will need to be wider.
g) The bedroom door position is fixed.
h) Accommodating the nurse "touchdown" base is difficult without adding additional width to the corridor.

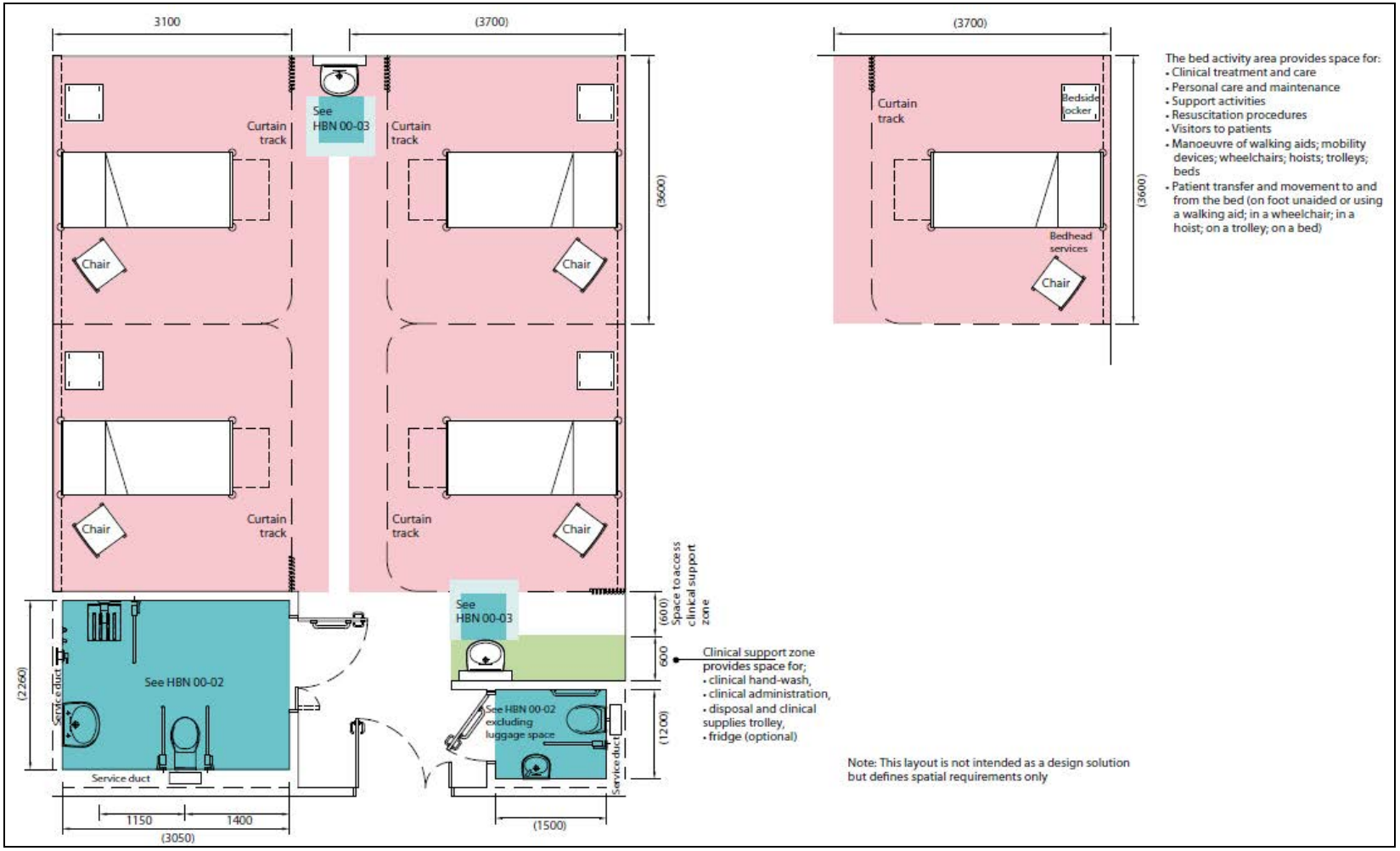
External en-suite

a) Access to room and en-suite are on opposite sides, which is less restrictive on room width.
b) View of the bed from the corridor is maximised.
c) External views are minimised.
d) Privacy for the patient is minimised and entry into the en-suite can be observed from the corridor.
e) There are three options for support services: part external wall, part corridor partitions and room partitions.
f) To accommodate bed turning, either the corridor or the bedroom doors will need to be wider.
g) The bedroom doors can be located flexibly on the corridor wall.
h) A nurse "touchdown base" can be accommodated adjacent to the bedroom door.

In-between en-suite

a) Interlocking en-suites increases overall width and depth of the room.
b) Views of the bed from the corridor are maximised.
c) External views are maximised.
d) Privacy for the patient is minimised and entry into the en-suite can be observed from the corridor.
e) There are two options for clinical support services: external wall or corridor partitions. This will be influenced by whether the en-suite is "nested" on the external or internal wall.
f) To accommodate bed turning, either the corridor or the bedroom doors will need to be wider.
g) The bedroom doors can be located flexibly on the corridor wall.
h) A nurse "touchdown" base can be accommodated adjacent to the bedroom door.

Figure 14: En-suite location



NOTE: Whilst the evidence base for the layout of this multi-bed room (as set out in 'Ward layouts with single rooms for space and flexibility') was based on optimum space standards, there has been a move towards providing minimum space standards, therefore some dimensions may have been marginally reduced.

Figure 15: Example layout for a four bedded room

Appendix 2: References

Legislation (current versions always to be used)

Disability Discrimination Act 1995 and 2005. The Stationery Office, 1995 (to be replaced by the Equality Act in late 2010). http://www.legislation.hmso.gov.uk

The Construction (Design and Management) Regulations 2007, The Stationery Office. http://www.legislation.hmso.gov.uk

The Control of Substances Hazardous to Health (COSHH) Regulations 2002. SI 2002 No 2677. The Stationery Office, 2002. http://www.legislation.hmso.gov.uk

The Manual Handling Regulations 1992, SI 1992: 2793. The Stationery Office, 1992.

The Health Act 2006: Code of practice for the prevention and control of healthcare associated infections. Department of Health, 2008.

Health Facilities Scotland

Scottish Health Planning Notes (SHPNs)

SHPN 04 Supplement 1: Isolation facilities in acute settings, Sept 2008**.**

SHPN 13 Decontamination facilities Part 2: Local decontamination units, Jun 2008**.**

SHPN 13 Decontamination facilities Part 3: Endoscope decontamination units, Sept 2010.

Scottish Health Technical Memoranda (SHTMs)

SHTM 55: Windows, Dec 2006**.**

SHTM 60: Ceilings, Oct 2009**.**

SHTM 61: Flooring, Jul 2009**.**

SHTM 64: Sanitary assemblies, Dec 2009**.**

Engineering publications

SHTM 00: Best practice guidance for healthcare engineering – Policy and Principles, Aug 2008**.**

SHTM 2005: Building management systems, Jun 2001**.**

SHTM 2007: Electrical services: supply and distribution, Jun 2001**.**

SHTM 2009: Pneumatic air tube transport systems, Jun 2001**.**

SHTM 2010: Sterilization, Jun 2001**.**

SHTM 2011: Emergency electrical services, Jun 2001**.**

SHTM 2014: Abatement of electrical interference, Jun 2001**.**

SHTM 2015: Bedhead services, Jun 2001**.**

SHTM 2022: Medical gas pipeline systems, Jun 2001**.**

SHTM 2024: Lifts, Jun 2001**.**

SHTM 2025: Ventilation in healthcare premises, Jun 2001**.**

SHTM 2031: Clean steam for sterilization, Jun 2001**.**

SHTM 2040: The control of Legionella in healthcare premises – A code of practice, Dec 1999**.**

SHTM 2045: Acoustics: Design considerations, Jun 2001**.**

SHGN: Structured cabling for IT systems.

SHGN: 'Safe' hot water and surface temperatures.

SHFN 14: Disability access, Sept 2000**.**

SHFN 30: Infection control in the built environment, Jan 2007**.**

HAI-SCRIBE (Healthcare Associated Infection System for Controlling Risk in the Built Environment), Jun 2007**.**

Wayfinding: effective wayfinding and signing systems guidance for healthcare facilities.

Guidance on the use of Mobile Communication Devices in healthcare premises.

The NHSScotland National Cleaning Services Specification, 2004.
http://www.scotland.gov.uk/Publications/2004/05/19319/36643

The NHSScotland Code of Practice for the Local Management of Hygiene and Healthcare Associated Infection.
http://cci.scot.nhs.uk/Publications/2004/05/19315/36624

CEL (2008) 48: Provision of single room accommodation and bed spacing.
Scottish Government http://www.sehd.scot.nhs.uk/mels/CEL2008_48.pdf

CEL (2010) 27: Provision of single room accommodation and bed spacing. Scottish Government http://www.sehd.scot.nhs.uk/mels/CEL2010_27.pdf

Scottish Capital Investment manual (SCIM), Scottish Government 2009 http://www.scim.scot.nhs.uk/

British Standards

BS 3621:2004 Thief resistant lock assemblies. Key egress. British Standards Institute, London.

BS 7671:2008 Requirements for electrical installations. IEE Wiring Regulations. 17th Edition (and subsequent amendments). British Standards Institute, London.

BS 8300:2009 Design of buildings and their approaches to meet the needs of disabled people – Code of practice. British Standards Institute, London.

BS-EN 12056-1:2000 Gravity drainage systems inside buildings, British Standards Institute, London.

Department of Health publications

HBN 00-02: Sanitary spaces. The Stationery Office, 2008.

HBN 00-03: Clinical and clinical support spaces. The Stationery Office, 2010.

HBN 00-04: Circulation and communication spaces. The Stationery Office, 2007.

HBN 04-01 Adult in-patient facilities. The Stationery Office, 2008.

An integrated approach to hospital cleaning. Research and development report, 2007.

Our health, our care, our say: a new direction for community services. Department of Health, 2006.

Privacy and dignity – a report by the Chief Nursing Officer into mixed sex accommodation in hospitals. Department of Health, 2007.

The art of good health – a practical handbook. The Stationery Office, 2002.

The art of good health – using visual arts in healthcare. The Stationery Office, 2002.

The essence of care. Department of Health, 2001.

Ward layouts with single-bed rooms for space and flexibility. Department of Health, 2005.

Other publications

BREEAM Healthcare. http://www.breeam.org/index.jsp under 'Communities'.

BSRIA Technical Note TN 9/92 – Space and Weight Allowances for Building Services Plant: Inception Stage Design. BSRIA, 1993.

BSRIA Technical Note TN 10/92 – Space and Weight Allowances for Building Services Plant: Detail Design Stage. BSRIA, 1992.

CIBSE 'Code for Lighting'. Chartered Institution of Building Services Engineers, 2006.

CIBSE Lighting Guide 2 – Hospitals and healthcare buildings. Chartered Institution of Building Services Engineers, 2008.

CIBSE Lighting Guide 7– Office lighting. Chartered Institution of Building Services Engineers, 2005.

CIBSE Guide F: 'Energy Efficiency in Buildings'. Chartered Institution of Building Services Engineers, 2004.

HSE Guidance Note EH40 – Workplace Exposure Limits. The Stationery Office, 2000.

Medical Electrical Installation Guidance Notes 'MEIGaN'. Medicines and Healthcare Products Regulatory Agency (MHRA), 2007.

Lighting and colour for hospital design – a report on an NHS Estates-funded research project. Dalke et al, 2004.

Safer surfaces to walk on – reducing the risk of slipping. CIRIA, 2006.

Appendix 3: Other useful publications

Legislation

The Building (Scotland) Regulations 2004 (and all subsequent amendments).

Chronically Sick and Disabled Persons Act 1970. The Stationery Office, 1970.

Health and Safety at Work etc Act 1974. HMSO, 1974.

Gas Safety (Installation and Use) Regulations 1998.
http://www.legislation.hmso.gov.uk

The Health and Safety (Safety Signs and Signals) Regulations, SI 1996: 341.
http://www.legislation.hmso.gov.uk

Management of Health and Safety at Work Regulations 1999, SI 1999: 3242.
http://www.legislation.hmso.gov.uk

The Workplace (Health, Safety and Welfare) Regulations 1992, SI 1992: 3004. The Stationery Office, 1992.

Control of Noise at Work Regulations 2005.

Health Facilities Scotland

Scottish Health Planning Notes (SHPNs)

SHPN 22: Accident and emergency facilities for children and adults.

SHPN 28: Facilities for cardiac services.

SHPN 54: Facilities for cancer services.

Scottish Health Technical Memoranda (SHTMs)

SHTM 56: Partitions.

SHTM 57: Internal glazing.

SHTM 58: Internal doorsets.

SHTM 59: Ironmongery.

NHSS Firecode

SHTM 81 Part 1: Fire precautions in new healthcare premises.

SHTM 81 Part 2: Guidance on the fire engineering of healthcare premises.

SHTM 82: Alarm and detection systems.

SHTM 87: Textiles and furniture.

Engineering publications

SHTM 2027: Hot and cold water supply, storage and mains services.

British Standards

BS-EN 60598-2-22:1999 Luminaires. Particular requirements. Luminaires for emergency lighting. British Standards Institute, London.

BS-EN 60601-1:2006 Medical electrical equipment. General requirements for basic safety and essential performance. British Standards Institute, London.

BS-EN 60601-1-2:2002 Medical electrical equipment. General requirements for safety. Collateral standard. Electromagnetic compatibility. Requirements and tests. British Standards Institute, London.

Department of Health publications

HBN 00-07: Resilience planning in the healthcare estate. The Stationery Office, 2007.

HBN 14-01: Pharmacy and radiopharmacy facilities. The Stationery Office, 2007.

HBN 13: Sterile services department. The Stationery Office, 2004.

HBN 26: Facilities for surgical procedures. The Stationery Office, 2004.

HBN 57: Critical care facilities. The Stationery Office, 2003.

Comprehensive critical care. Department of Health, 2000.

Creating a patient-led NHS. Department of Health, 2005.

Governance in the new NHS. HSC 2001-05. Department of Health, 2001.

Quarterly Briefing. Department of Health, published quarterly.

Other publications

A Professional Approach to Managing Security in the NHS. NHS Security Management Service, 2003.
www.cfsms.nhs.uk/doc/sms.general/sms.strategy.pdf

Directions to NHS Bodies on Security Management Measures 2004 (Amendment) Directions 2006.
www.cfsms.nhs.uk/doc/sms.general/nhs.sms.amendment.directions.01.04.06.pdf

IEE Guidance Note 7 (Special Locations). Institute of Engineering and Technology (IET), 2004.

EH 40 Occupational Exposure Limits. Health and Safety Executive (updated annually).

Hospital interior architecture: creating environments for special patient populations. Malkin, Jain. Van Nostrand Reinhold, New York, 1992.

Patient-focused architecture for health care. Scher, Peter. Arts for Health, Manchester Metropolitan University, 1996.

Patient handling in health care. SIM 7/2001/44. Health and Safety Executive, December 2001.

Status report: an investigation to determine whether the built environment affects patients' medical outcomes. Rubin HR, Owens AJ and Golden G. The Center for Health Design, 1998.

Appendix 4: Useful websites

Health facilities Scotland - http://www.hfs.scot.nhs.uk/

Medicines and Healthcare Product Regulatory Agency - http://www.mhra.gov.uk/Publications/index.htm

BSI Shop - http://www.bsi-global.com/upload/Standards%20&%20Publications/shop.html?epslanguage=EN

Scottish Building Standards - http://www.scotland.gov.uk/Topics/Built-Environment/Building/Building-standards

Royal college of Nursing - http://www.rcn.org.uk/

NHS Quality Improvement Scotland - http://www.nhshealthquality.org/nhsqis/43.144.140.html

Space for Health, Information for healthcare premises professionals - http://www.spaceforhealth.nhs.uk/space-health

Scottish Government Health Directorates - http://www.sehd.scot.nhs.uk/

Classification: Official

Publications approval reference: PAR38

Health Technical Memorandum 03-01 Specialised ventilation for healthcare premises
Part A: The concept, design, specification, installation and acceptance testing of healthcare ventilation systems

A47851278

Preface

This HTM was prepared prior to the COVID-19 pandemic caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). It has been reviewed against the known transmission evidence available at the time of publication. Ventilation is one of many mitigations against the virus and should be part of a package of infection prevention and control measures. The ventilation rates recommended in this document are likely to provide a lower risk environment for COVID-19 airborne transmission. Emerging evidence will continue to be reviewed as and when available.

About Health Technical Memoranda

Health Technical Memoranda (HTMs) give comprehensive advice and guidance on the design, installation and operation of specialised building and engineering technology used in the delivery of healthcare.

The focus of Health Technical Memorandum guidance remains on healthcare-specific elements of standards, policies and up-to-date established best practice. They are applicable to new and existing sites, and are for use at various stages during the whole building lifecycle.

Language usage in technical guidance

In HTMs and HBNs, modal verbs such as "must", "should" and "may" are used to convey notions of obligation, recommendation or permission. The choice of modal verb will reflect the level of obligation needed to be compliant.

The following describes the implications and use of these modal verbs in HTMs/HBNs (readers should note that these meanings may differ from those of industry standards and legal documents):

- "Must" is used when indicating compliance with the law.
- "Should" is used to indicate a recommendation (not mandatory/ obligatory), i.e. among several possibilities or methods, one is recommended as being particularly suitable – without excluding other possibilities or methods.
- "May" is used for permission, i.e. to indicate a course of action permissible within the limits of the HBN or HTM.

Typical usage examples

- "All publicly-funded organisations must ensure that all contracts established to collect and treat waste

This guidance is not mandatory (unless specifically stated). However, any departures/ derogations from this HTM – including the measures implemented – should provide a degree of safety not less than that achieved by following the guidance set out in this HTM.

conform to the Public Contracts Regulations." [obligation]

- "All low voltage (LV) distributions should be configured as TN systems." [recommendation]
- "Alcohol hand gels that do not contain siloxanes may be rinsed out and the packaging recycled or placed into the municipal waste stream." [permission]

"Shall", in the obligatory sense of the word, is never used in current HTMs/HBNs.

Project derogations from the Technical Guidance

Healthcare facilities built for the NHS are expected to support the provision of high-quality healthcare and ensure the NHS Constitution right to a clean, safe and secure environment. It is therefore critical that they are designed and constructed to the highest and most appropriate technical standards and guidance. This applies when organisations, providers or commissioners invest in healthcare accommodation (irrespective of status, for example Foundation and non-Foundation trusts).

Statutory standards plus technical standards and guidance specific to NHS facilities:

Health Building Notes

Health Technical Memoranda

Complete list of NHS estates-related guidance

The need to demonstrate a robust process for agreeing any derogation from Technical Guidance is a core component of the business case assurance process.

The starting point for all NHS healthcare projects at Project Initiation Document (PID) and/or Strategic Outline Case (SOC) stage is one of full compliance.

Derogations to standards will potentially jeopardise business case approval and will only be considered in exceptional circumstances. A schedule of derogations will be required for any project requiring external business case approval and may be requested for those that have gone through an internal approvals process.

While it is recognised that derogation is required in some cases, this must be risk-assessed and documented in order that it may be considered within the appraisal and approval process.

Derogations must be properly authorised by the project's senior responsible owner and informed and supported by appropriate technical advice (irrespective of a project's internal or external approval processes).

Sustainability and 'Net Zero Carbon' targets

Healthcare provision is a significant contributor to the UK's carbon footprint. (In 2019, this was estimated to be around 5.4% of our greenhouse gases.) Accordingly, all NHS organisations have their part to play in meeting Net Zero Carbon targets alongside other sustainability measures.

In January 2020, Health chief Sir Simon Stevens announced three steps the NHS will take during 2020 to tackle this problem:

- NHS England has established an expert panel to chart a practical route map to enable the NHS to get to 'net zero'. The panel will submit an interim report to NHS England in summer 2020 and a final report ahead of the November 2020 UN Climate Change Conference (COP26) in Glasgow. The panel will consider changes the NHS can make in its own activities; in its supply chain; and through wider partnerships;

- the NHS Long Term Plan commits to better use of technologies to make up to 30 million out-patient appointments redundant, sparing patients thousands of unnecessary trips to and from hospital. It is estimated that 6.7 billion road miles each year are from patients and their visitors travelling to the NHS;
- the panel will consider changes that can be made in the NHS's medical devices, consumables and pharmaceutical supply, and areas the NHS can influence such as the energy sector as the health service moves to using more renewable energy.

For specific ventilation-related measures, see the "Net Zero Carbon" section on page vi.

Executive summary

Preamble

Health Technical Memorandum 03-01 – 'Specialised ventilation in healthcare premises' is published in two parts:

Part A: The concept, design, specification, installation and acceptance testing of healthcare ventilation systems.

Part B: The management, operation, maintenance and routine testing of existing healthcare ventilation systems.

The documents give comprehensive advice and guidance on the legal requirements, design implications, maintenance and operation of specialised ventilation in healthcare premises providing acute care. The use of these premises is very intense, the occupancy level high and the patients may be particularly susceptible to airborne infection risks. Their condition may also require close control of the environment.

The ventilation of non-healthcare facilities within the hospital curtilage should be designed to suit the application and specific guidance relating to the activity should be followed, for example pharmacy, sterile services department, etc. However, as they are on the hospital site, the means of providing ventilation should not adversely impact upon the hospital (for example, evaporative cooling towers should not be installed, sound levels should be appropriate and if the facility is within or attached to an area accessed by patients, their needs and the risk of airborne contamination should be considered).

In other types of healthcare facility that are outside of the hospital curtilage, for example GP practices, health centres, minor injuries units, dental, ophthalmic and podiatry clinics, mental health facilities, respite and long stay care homes and hospices, a risk assessment of the nature of the treatment being delivered, condition of the patients and intensity of use needs to be undertaken by those responsible for the facility in order to determine the extent to which this guidance will be applicable.

The guidance contained in Part A of this Health Technical Memorandum applies to new installations and major refurbishments of existing installations and should be considered as the standard to be achieved.

The guidance contained in Part B of this Health Technical Memorandum applies to all ventilation systems installed in healthcare premises irrespective of the age of the installation and should be considered as the standard to be achieved.

Health Technical Memorandum 03-01 (2021) supersedes all previous versions of Health Technical Memorandum 03-01 – 'Specialised ventilation in healthcare premises' (2007). It also supersedes HTM 2025 (1994) and DV4 (1983).

Who should use this guidance?

This document is aimed at specifiers, designers, suppliers, installers, estates and facilities managers and operations. Elements of the document will also be relevant to managers concerned with the day-to-day management of healthcare facilities and senior healthcare management.

Main changes since the 2007 edition

- Design information for specific healthcare applications has been revised and information on the reason for ventilation given. For example, endoscopy rooms are now negative pressure to contain and remove odours and manage airborne risks to staff. These endoscopy-specific risks (i.e. waste anaesthetic gases and pathogenic material (for example, multi-drug-resistant tuberculosis) discharged by the patient during the procedure being undertaken) were identified prior to the SARS-CoV-2 pandemic. As with other elements in Part A, the application of this change is not retrospective but applies to new installations and major refurbishments (see Preamble above).
- The client's needs and legal requirements are more clearly explained.
- This edition of Health Technical Memorandum 03-01 introduces the concept of the Ventilation Safety Group in healthcare organisations (similar to the Water Safety Group in Health Technical Memorandum 04-01 and the Electrical Safety Group in Health Technical Memorandum 06-01). This is a multidisciplinary group whose remit will be to assess all aspects of ventilation safety and resilience required for the safe development and operation of healthcare premises.
- The HTM introduces a standard method of identifying and labelling ventilation systems and the creation of an inventory of installed systems.
- The issues of resilience and diversity are addressed.
- Guidance is provided on refurbishments or when changing the use of an existing installation.
- Guidance is given on lifecycle and the updating of mid-life plant.
- Design information for specific healthcare application has been extensively revised.
- Issues around rooms where anaesthetic agents are used are addressed.
- Airflow rates are more tailored to the applications to take advantage of new fan and control technology and so reduce energy consumption.
- Revised air quality and filter standards are given.
- New and emerging technologies are catered for.
- Advice is given on installation standards and the appointment of an independent validator.
- More detailed information is given on the commissioning process.
- Validation acceptance standards and methodology has been completely revised.
- Routine inspection and maintenance guidance has been revised and updated.

Net zero carbon

Health Technical Memorandum 03-01 supports UK legislation to bring all greenhouse gas emissions to net zero by 2050, and promotes sustainable methods of ventilation in healthcare facilities. The

HTM's core principle is that the default method of ventilation should as far as possible be natural ventilation followed by mixed mode (natural with mechanical ventilation), with mechanical ventilation being the last option.

The energy consumption of ventilation systems should be further minimised by specifying solutions with the lowest lifecycle environmental cost. The basic objective of energy-saving strategies in this HTM is to provide the required ventilation service using the minimum energy. To this end, Health Technical Memorandum 03-01 recommends switching a system "off" when not required to be the most energy-efficient policy. If the system is needed to maintain a minimum background condition, reducing its output by "setting back" to the minimum necessary to achieve and maintain the desired condition is the next best option.

Fans represent an enormous potential for energy savings to reduce carbon emissions, as they are among the largest single users of energy (they use approximately 40% of all electricity in ventilation systems). The European Regulation 1253/2014, implementing the Energy-related Products (ErP) Directive, has significantly reduced the power to drive fans. Accordingly, Health Technical Memorandum 03-01 recommends using electronically commutated fans, as these have been proven to be the most energy-efficient, while also advising that belt-driven fans should no longer be installed.

There have been many legislative changes aimed at reducing energy consumption and technical advances that have increased operational efficiency. This revised HTM incorporates those changes and has amended many of the design parameters for healthcare ventilation. Designs that are simply repeated from previous installations designed to superseded standards and guidance will not meet the revised energy or operational standards and will not produce a compliant result.

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Colin Gaffney, Authorised Engineer (Ventilation), Specialised Ventilation for Healthcare Society

Conor Sage, Head of Operations, Northern Health and Social Care Trust, Northern Ireland

Craig Mackintosh, Clinical Scientist

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Dylan Evans, Senior Performance Standards Engineer, NHS Wales Shared Services Partnership - Specialist Estates Services

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Ian Ferguson, Capital Projects, University Hospitals of Morecambe Bay NHS Foundation Trust

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John Rayner, Authorising Engineer (Ventilation), IHEEM

Jon Fletcher, Operations Director, Interfurn Medical Systems

Karren Staniforth, Clinical Scientist, Healthcare Infection Society

Kevin Reynolds, Head of Estates, Sandwell and West Birmingham Hospitals NHS Trust

Kevin Ridge, Head of Engineering, NHS Wales Shared Services Partnership - Specialist Estates Services

Lester Stuart

Linda Dempster, Head of Infection Prevention and Control, NHS England & NHS Improvement

Malcolm Thomas, Main author

Martin Sarungi, Orthopaedic Surgeon, Golden Jubilee National Hospital, Clydebank

Michael Ralph, Principal Engineering & Senior Policy/Strategy Lead (Hard FM), NHS England & NHS Improvement

Michael Rope, Estates & Facilities Management Guidance Lead, NHS England & NHS Improvement

Mike Arrowsmith, Consulting Engineer, IHEEM

Mike Dunne, Technical Manager, Howorth Air Technology Limited

Mike Hodges, Managing Director, Apreco Limited

Nigel Keery, Head of Estates, Belfast Health & Social Care Trust

Peter Broadbent, Director, Couch Perry & Wilkes LLP

Peter Hickey, Assistant Director of Estates, Lancashire Teaching Hospitals NHS Foundation Trust

Peter Hoffman, Consultant Clinical Scientist, Public Health England

Richard Barry, Director, AirisQ Ltd

Richard Harris, Authorised Engineer (Ventilation), Specialised Ventilation for Healthcare Society

Rob Townsend, Consultant Medical Microbiologist, Sheffield Teaching Hospitals NHS Foundation Trust

Robert Porter, Consultant in Clinical Microbiology & Infection, Royal Devon and Exeter NHS Foundation Trust

Rosemary Jenssen, ProCure 22 Framework Representative

Sigrid Volkmann

Simon Allen, Torbay and South Devon NHS Foundation Trust

Simon Dale, Association of Anaesthetists, Chesterfield Royal Hospital NHS Foundation Trust

Steve Clifford, Consulting Engineer, Hoare Lea

Tim Boswell, Consultant Medical Microbiologist, Healthcare Infection Society

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Contents

1.0 Introduction

The needs of the building occupants

1.1 Ventilation is used extensively in all types of healthcare premises to provide a safe and comfortable environment for patients and staff and control odours. More specialised ventilation is provided to help reduce airborne infection risks in areas such as operating departments, critical care facilities, isolation rooms and primary patient treatment areas.

1.2 The Health and Social Care Act places a duty of care on healthcare providers. Increased health risks to patients will occur if ventilation systems do not achieve and maintain the required standards. The link between surgical site infection and theatre air quality has been well established. If the ventilation plant has been installed to dilute or contain harmful substances, its failure may expose people to unacceptable levels of risk. Proven breaches of the statutory requirements can result in prosecution and may also give rise to a civil suit against the operators.

The building environment

1.3 Healthcare buildings are visited and used by large numbers of people. Many will be unwell or anxious so a well-ventilated environment with a fresh feel and an absence of noxious odours is essential.

1.4 Ventilation may also be installed:

- to ensure compliance with the quality assurance requirements of items processed in pharmacies and sterile services departments;
- to protect staff from airborne microorganisms and toxic substances (for example, in laboratories and anaesthetic rooms);
- to contain the spread of smoke between fire compartments as part of the fire strategy.

1.5 Healthcare buildings are continuously occupied, intensively used and because of the specialised nature of the facilities it may be extremely difficult to provide the service elsewhere if the ventilation fails. In order to ensure continuity of service, ventilation systems should be designed and installed so that they can be quickly and easily maintained. The resilience of the proposed system in the event of service outage should also be considered.

1.6 The ventilation of healthcare facilities consumes a significant portion of their energy load, so wherever possible natural ventilation is the preferred option. Where mechanical ventilation is used, sustainable design concepts allied to good-quality installation and the provision of controls that maintain the desired environment when the facility is in use will result in the

minimum energy input for the maximum benefit.

Airborne risks to staff

1.7 Most healthcare staff are no more at risk from airborne hazards when at their workplace than they are when not in a healthcare environment; however, certain groups as detailed below may be exposed to a variety of airborne contaminants.

- Staff who administer anaesthetic agents or who work in areas where they are routinely used will be at risk of casual exposure to these agents.
- Staff who routinely work in areas where they may come into close contact with patients who have respiratory symptoms will be at risk of exposure to the microorganisms causing the symptoms.
- Staff who routinely work in areas where they may come into close contact with patients that have skin lesions, an infectious disease or a dermatological condition will be at risk of exposure to the microorganisms causing the condition.
- Staff who routinely process pathology specimens.
- Staff who decant, mix and/or process chemicals used as reagents for the setting or processing of pathology specimens.
- Staff who harvest organs, tissues and specimens at a post-mortem.
- Staff who handle drugs or the components of drugs.
- Staff who pre-clean used scopes, surgical instruments and equipment prior to decontamination.
- Staff who may be routinely exposed to airborne hazards listed in EH40 issued under the Control of Substances Hazardous to Health Regulations (COSHH) (for example, woodworking dust, welding fumes, chemical vapours).

1.8 A well-designed ventilation system can mitigate the airborne risks to staff. It should:

- supply sufficient unvitiated air to dilute the possible contaminants;
- have air terminals located to efficiently scour the ventilated space;
- move the air from the clean to the less clean space and/or out of the building;
- supply the air at high level and remove it at low level so that the breathing zone of staff is in a clean airflow path.

1.9 Adoption of these principles will be sufficient to control the general risk to the staff identified above in their particular working environment. More specific airborne hazards should be captured at source and removed by local exhaust ventilation (LEV) systems provided under the COSHH Regulations (see paragraphs 3.3–3.5).

Airborne risks to patients

1.10 In general terms an environment that is satisfactory for staff will be satisfactory for patients. There are, however, exceptions as below:

- intensive treatment units of any type;
- haematology/oncology units;
- transplant units and units treating patients that have had their immune system compromised;
- bone marrow transplant units (BMT);
- burns units;
- cystic fibrosis units;

- operating theatres.

Patients being treated in these areas will need an environment supplied with good-quality filtered air and that is maintained at a positive pressure with respect to surrounding areas.

Note:

Patients who are particularly at risk from airborne microorganisms will normally be placed in an isolation room or suite that is maintained at a positive pressure. Patients who have a condition that could be transmitted to others are normally placed in a negative pressure isolation suite. When the patient's exact condition is unknown they may be placed in a neutral pressure (PPVL) isolation suite (see Health Building Note 04-01 Supplement 1 – 'Isolation facilities for infectious patients in acute settings' for detailed guidance).

1.11 A more general airborne risk will result from poorly designed and constructed air handling units (AHUs) that allow water to stagnate inside; they can then become a source of microorganisms such as *Legionella*. If their intake is badly sited or housekeeping in the area is poor, fungal spores such as aspergillus can be drawn in. The ventilation system will then become a means of spreading these microorganisms and fungal spores around the healthcare building.

1.12 All ventilation systems should conform to the principles set out in the Health and Safety Executive's (HSE) Approved Code of Practice and guidance document HSG274 'Legionnaires' disease: the control of *Legionella* bacteria in water systems' and Health Technical Memorandum 04-01 – 'Safe water in healthcare premises'.

Specialist equipment environment

1.13 Imaging and other non-invasive scanning equipment will require stable environmental conditions to stay within calibration and provide accurate repeatable results. Health Building Note 06-01 and Health Building Note 10 (2021) give detailed guidance and the equipment manufacturers should be consulted.

Note:

Health Building Note 26 – 'Facilities for surgical procedures' (2004) and Health Building Note 10-02 – 'Facilities for day surgery units' (2007) are under revision at the time of writing and will become Health Building Note 10-01 once updated.

Health Building Note 06-01 (2001) on diagnostic imaging and interventional radiology is also under revision at the time of writing.

Medicinal products environment

1.14 Pharmacists are required to ensure that any manufacture or preparation activities involving medicinal products undertaken in their units conform with the requirements of the Medicine Act. Processes must be carried out in a suitable facility usually termed an aseptic preparation facility. The quality of air supply and design of the ventilation cascade are essential to ensure a suitable environment for the activities undertaken.

Fire and smoke control fundamentals

1.15 Health Technical Memorandum 05 is the base document for fire aspects. When designing a ventilation system, a fire and

smoke control strategy should be developed that is relevant to the site and its function. The fire and smoke strategy should take account of the planned activity within the area, the type of patient present, staff-to-patient ratio and treatment being delivered (see also Chapters 5 and 7).

1.16 When ventilation systems are originally designed, they will conform to an agreed fire strategy. This will determine the compartmentation, provision of fire-rated ductwork, fitting of sprinklers, the siting of fire and smoke dampers and an agreed control action for the ventilation in the event of a fire. The agreed fire and smoke control strategy must be clearly set out as part of the design specification.

1.17 The fire regulations require that, if ventilation ductwork penetrates the fabric of a building, it should be designed and installed to contain the spread of fire (see Health Technical Memorandum 05-02 – 'Guidance in support of functional provisions for healthcare premises' for further guidance).

1.18 If a ventilation system is upgraded or altered to suit a change of use, it will be necessary to reassess the fire strategy.

1.19 It is management's responsibility to ensure that the fire strategy applied during the design and installation of a system is not reduced during the subsequent operation and maintenance of the equipment.

1.20 The number and location of fire and smoke dampers can be problematic. Fire-rated ductwork within fire zones will reduce the need for fire and smoke dampers. It will eliminate the need to provide access for routine damper testing and the infection control problems associate with reversed airflow paths resulting from damper failures and nuisance tripping (see also Chapter 7 for ventilation control in the event of fire).

Note:

In developing a fire and smoke containment strategy the design of ventilation for infection control cannot be ignored. Over-compartmentation and poorly chosen fire lines can prevent air moving from clean to less clean areas and thus increase the infection risk. This can be a particular problem in operating departments where the desire to create a protected escape route can be at odds with the need to cascade air through a suite of rooms and out into a corridor in order to control the airborne infection risk.

2.0 The user requirements

2.1 Patient treatment falls into four basic categories:

- Surgical procedures – physical interventions to diagnose, repair, remove or rebuild damaged or infected tissue.
- Medical care – the administering of drugs or various forms of practical, non-invasive treatment to diagnose, cure or reduce the severity of an infection or condition.
- Mental health – the use of counselling, often in conjunction with drugs, to control or alleviate abnormal behavioural or false perception issues in patients.
- Palliative care – treatment to temporarily or partially relieve or mitigate long-term conditions.

In all cases a patient may require treatment in one or more of the categories as either an in-patient or an out-patient.

Surgical procedures

2.2 It is thought that up to 25% of infections that occur as a result of a surgical intervention are caused by the airborne route. The source of these infections are predominantly as a result of airborne microorganisms, typically skin scales, liberated during the surgical procedure becoming airborne and landing in the wound or on surgical instruments. These then become a means of inoculating the patient with the contaminant. There are five possible routes that may result in airborne infections:

- Skin scales liberated by the surgical team during the procedure.
- Organic material liberated from the patient as a result of the procedure.
- Microorganisms remaining from a previous use of the space becoming airborne.
- Airborne microorganisms liberated outside of the space entering during the procedure.
- Microorganisms in the supply air from a ventilation system that has been contaminated with biological material.

2.3 The level of airborne organic material present or biological burden (bioburden) is typically defined in terms of the number of colony forming units (cfus) present at the wound site during the procedure. It will be dependent on:

- the number of persons present;
- the completeness and effectiveness of their gowning;
- the duration of the procedure;

- the type of procedure;
- the use of air-driven power tools;
- the extent to which a patient contributes to the bioburden in the space;
- the general cleanliness of the space;
- the discipline of the surgical team;
- the measures that have been taken to prevent or control contaminants from outside sources entering the space;
- the quality and volume of the incoming supply air;
- the efficiency of the incoming air to "scour" the space;
- the means of removing contaminated air from the space.

2.4 Good surgical discipline, effective patient preparation, the cleanliness of the space and control of the entry and exit of personnel during the procedure will all contribute to reducing the bioburden present.

2.5 A well-designed ventilation scheme that provides a suitable quality of air and efficiently scours the space will further reduce the bioburden. If the ventilation maintains the space at a positive pressure to adjoining areas, the risk of contaminants originating outside of the space entering will be reduced.

2.6 In addition to controlling the bioburden, the ventilation should provide comfortable conditions for the staff and patient.

2.7 The ventilation system should also control the risks to staff from anaesthetic agents and other hazardous fumes and emissions typically found in surgical facilities (see paragraphs 1.10–1.12).

2.8 Minor procedures may be carried out in a treatment room or at the bedside so surgical procedures are not exclusive to the operating department. (See Humphreys *et al* (2012) for further guidance on facilities for minor surgical procedures and minimal access interventions.)

Medical care

2.9 In general the main requirement will be to ensure that staff and patients are kept in comfortable conditions.

2.10 There are specific instances where staff can be at risk of contracting an illness by the airborne route from a patient. This is the case in infectious disease units where the ventilation will be designed to maintain the unit and individual patient rooms at negative pressure relative to adjacent areas. This will protect persons outside of the unit from infection by the airborne route but not staff entering and working in the unit, who may need to take additional precautions to protect themselves.

2.11 The opposite problem occurs when patients are neutropenic, that is, they have a reduced or extremely low resistance to infection. They are then at risk of infection by the airborne route from other persons such as staff and visitors. This will be the case in cancer/oncology units, critical care areas, and bone marrow and general transplant units. The ventilation in these areas will need a higher air quality and be set to maintain a positive pressure to adjacent areas.

Mental health

2.12 Any specific patient needs should be assessed and addressed. The main requirement will be to ensure that staff and patients are kept in comfortable conditions (see comments on other types of healthcare facility in the Executive Summary).

2.13 The fire risk may be considered more likely and additional steps may need to be taken to control it.

Palliative care

2.14 The main requirement is to ensure that staff and patients are kept in comfortable conditions. Temperature control may be more stringent for patients with long-term and/or end of life conditions (see the Executive Summary for further information).

2.15 Difficulties with evacuating patients in the event of fire may need to be considered.

Diagnostic and support services

Imaging and Interventional imaging

2.16 There are major advances in diagnosis and minimally invasive treatment involving imaging. It may be necessary during these invasive or non-invasive procedures to provide sedation or general anaesthesia to help with anxiety or pain. This may involve the use of inhaled anaesthetic agents and/or nitrous oxide (N_2O). Staff working in these areas may be exposed to these anaesthetic agents when they are administered or subsequently when they are exhaled as the patient is recovered.

2.17 A similar situation occurs in maternity units, where a mixture of nitrous oxide and oxygen (N_2O/O_2) (Entonox) is used as an inhaled analgesic.

2.18 In both of the above cases ventilation should be designed to provide a clean airflow path and dilute any casual spillages of the gas. This approach will help control the casual exposure of staff to the anaesthetic agent (see paragraphs 3.3–3.5).

Post-mortem and pathology

2.19 Staff who harvest organs and specimens at a post-mortem and place them into preservative solutions may be exposed to the microorganisms present and fumes from the preservative.

2.20 Staff who section organs and prepare specimens for analysis may be exposed to the microorganisms present and the chemicals used for staining and fixing the specimens.

2.21 In both of the above situations local exhaust ventilation (LEV) in the form of downflow benches, safety cabinets and fume cupboards need to be provided to control the risk.

Pharmacy

2.22 Exposure to the active ingredients of drugs represents a hazard to pharmacy staff who are involved in their production. These activities are carried out in an aseptic preparation facility to ensure that the drugs themselves are not contaminated. The actual production typically takes place inside an isolator so that there is a physical barrier between the hazard and the operator.

2.23 Alcohol sprays are used and staff exposure may be controlled by the provision of downflow LEV systems to remove the hazard.

2.24 Comfortable conditions are essential for staff working in preparation facilities as they need to be fully gowned, and entry and exit is restrictive.

Decontamination facilities

2.25 Staff may be exposed to airborne biological material and chemicals when handling and processing used scopes, surgical instruments and equipment as part of the decontamination process. The ventilation should provide a clean airflow path to control staff exposure.

Estates and facilities

2.26 Staff may be engaged in welding, soldering, machining wood or paint-spraying. They may also decant chemicals in quantity (for example, for boiler treatment or hydrotherapy-pool dosage). LEV systems are routinely used to control the hazards arising.

3.0 Legal requirements – applicable legislation

Health and Safety at Work etc Act

3.1 The Health and Safety at Work etc Act 1974 is the core legislation that applies to ventilation installations. As these installations are intended to prevent contamination, closely control the environment, dilute contaminants or contain hazards, their very presence indicates that potential risks to health have been identified.

3.2 The Act places a duty of care on ALL to provide and maintain a safe workplace. This includes designers and suppliers of goods or services. Those trading as competent designers or suppliers are therefore liable to provide outcomes that meet the client's needs and are without hazard to staff, patients and others who may be affected by the work activity.

Control of Substances Hazardous to Health Regulations

3.3 The Control of Substances Hazardous to Health (COSHH) Regulations 2002 place upon management an obligation to ensure that control measures are in place to protect their staff and others affected by the work activity. These methods may include both safe systems of work and the provision of a specialised ventilation system. In laboratories the requirements are often met by the provision of fume cupboards and microbiological safety cabinets.

3.4 Where specialised ventilation plant is provided as part of the control measures, there is a statutory requirement that it be correctly designed, installed, commissioned, operated and maintained. The local exhaust ventilation (LEV) section of COSHH requires that the system be examined and tested at least every 14 months by a competent person (P601 certified) and that management maintain comprehensive records of its performance, repair and maintenance.

3.5 Certain substances have workplace exposure limits (WELs) as set out in the Health and Safety Executive's (2005) Guidance Note EH40 – 'Workplace exposure limits'. This contains the list of workplace exposure limits for use with the Control of Substances Hazardous to Health Regulations 2002 (as amended). If specialised ventilation systems are provided in order to achieve these standards, they will be subject to the COSHH Regulations.

Workplace (Health, Safety and Welfare) Regulations

3.6 These state that:

- All enclosed workplaces must be ventilated by natural or artificial means.
- Any plant provided under this legislation must include an effective device to give an audible or visual warning of plant failure where necessary for health and safety.
- The Regulations require that ventilation systems are maintained in an efficient state, in efficient working order and in good repair.

The Building Regulations

3.7 Approved documents L and F:

- apply to domestic and non-domestic buildings;
- clarify satisfactory methods of providing ventilation and give ventilation rates;
- set minimum standards for:
  - the protection of the supply position
  - precautions against *Legionella*
  - the purity of recirculated air
  - access for service and maintenance
  - documentation and proof of performance
  - energy performance.

Health and Social Care Act 2008 (Regulated Activities) Regulations 2014

3.8 Regulation 12(2)(h) of the Act decrees that registered providers must assess the risk of, and prevent, detect and control the spread of, infections, including those that are healthcare associated.

3.9 Appropriate standards of cleanliness and hygiene should be maintained in premises used for the regulated activity. DH (2015) issued 'The Health and Social Care Act 2008 Code of Practice on the prevention and control of infections and related guidance' (the HCAI Code of Practice), which contains statutory guidance about compliance with regulation 12(2)(h).

3.10 Regulation 15 of the Act states that:

(1) All premises and equipment used by the service provider must be:

a. clean,

b. secure,

c. suitable for the purpose for which they are being used,

d. properly used

e. properly maintained, and

f. appropriately located for the purpose for which they are being used.

(2) The registered person must, in relation to such premises and equipment, maintain standards of hygiene appropriate for the purposes for which they are being used.

Note:

The "registered person" means, in respect of a regulated activity, the person who is the service provider or a registered manager in respect of that activity. A "service provider" means a person registered with the CQC under Chapter 2 of Part 1 of the Health and Social Care Act 2008 as a service provider in respect of that regulated activity.

The Medicines Act 1968 and Human Medicines Regulations 2012

3.11 Pharmacy aseptic preparation facilities should conform to the requirements of EudralLex – Volume 4 – Good Manufacturing Practice (GMP) guidelines or equivalent UK legislation, and the requirements of the UK Medicines Inspectorate (MHRA) if a licensed manufacturing unit.

3.12 There are specific requirements under the Medicines Act 1968 to maintain accurate records of plant performance, room conditions and maintenance events. Such records would need to be preserved for up to 25 years as part of a quality assurance audit trail.

3.13 Specialised ventilation plant installed in laboratories dealing with research, development or testing, whether involving drugs, animals or genetically modified microorganisms, may be subject to legislation regarding their operation in addition to that mentioned above.

Indoor air quality (IAQ)

3.14 There is increasing awareness that IAQ has an important impact on health and well-being. The World Health Organization and the Royal College of Paediatrics and Child Health (2020) have produced papers on the importance of IAQ, and the National Institute for Health and Care Excellence (NICE) (2020) has issued guidelines for domestic environments. Indoor and outdoor sources of contaminants are important contributors to IAQ, and designers of ventilation systems should consider both. The Department for Environment, Food and Rural Affairs (Defra) gives data for outdoor air quality by postcode for the UK. This enables designers to choose suitable filter grades by location and application (see the Specialised Ventilation for Healthcare Society's (2018) SVHSoc.02 – 'Change in air filter test and classification standards' for further information).

Other relevant standards and sources of guidance

3.15 The Chartered Institution of Building Services Engineers (CIBSE) Guides and associated published documents (TMs) are the principal source of general ventilation specification and design guidance.

3.16 ISO 14644 provides basic information on clean rooms used in pharmacy preparation facilities and inspection, assembly and packing (IAP) rooms for the processing of medical devices in sterile services departments.

3.17 BS EN 15780 applies to both new and existing ventilation and air-conditioning systems and specifies the assessment criteria of cleanliness and cleaning procedures of these systems.

3.18 HSG 258 issued by the Health & Safety Executive provides guidance on the design of local exhaust ventilation (LEV) systems.

3.19 Other relevant guidance is listed in the References.

Note:

In all cases the most recent version of any legislation, regulation, standard or guidance document should be consulted.

4.0 The design and specification process

Project brief

4.1 The ventilation aspects of a contract will normally form part of a wider project to provide, upgrade or replace a healthcare facility. It is important that the ventilation designer closely liaises with the architect, as the layout of the facility and the adjacency of spaces within it will have a major impact on the ability of the ventilation system to achieve the client's requirements. All new major projects are required to use building information modelling (BIM) in order to ensure a coordinated design and provide information for the subsequent operation and possible future development of the facility.

4.2 The Building Services Research and Information Association (BSRIA) has produced an approach to project delivery known as "Soft landings" (BSRIA, 2018). It aims to ensure that the client's success criterion is kept in focus during the inception and briefing, design, construction, pre-handover, initial aftercare and extended aftercare phases of a project. It is strongly recommended that the client and project contractor adopt this approach.

Basis of design

4.3 This HTM assumes that designers will be familiar with current CIBSE guidance and will use it as the basis for specifying and designing ventilation systems. However, the actual guidance contained in this HTM may differ from the CIBSE guidance due to healthcare-specific issues and will take precedence over the CIBSE guidance where there are conflicts.

Note:

Health Technical Memorandum 03-01 Parts A and B need to be read and considered in their entirety when specifying and designing ventilation systems to ensure that the end result will comply with the client's needs.

Ventilation Safety Group (VSG)

4.4 The management of the ventilation systems of a healthcare provider should be overseen by a Ventilation Safety Group (VSG). The VSG should have clearly defined roles and responsibilities, be part of a healthcare organisation's governance structure and report to the "Designated Person" at Board level. It should be led and

chaired by a person who has appropriate management responsibility, knowledge, competence and experience (for example, the Designated Person). (See Chapter 2 in Part B of Health Technical Memeorandum 03-01 for further information.)

4.5 The VSG should be a multidisciplinary group and should typically comprise:

- an Authorising Engineer/independent adviser for ventilation (AE(V));
- an Infection Prevention and Control person;
- the Authorised Person(s) for ventilation services (AP(V));
- estates (operations and projects) staff;
- clinicians and specialist departments (for example, theatres, critical care areas, pharmacy, medical microbiology, nursing, decontamination);
- personnel from the finance department with accountability for capital and revenue evaluation;
- other stakeholders as appropriate;
- coopted expertise (for example, ventilation designers, consultants and suppliers).

4.6 The VSG remit should be to assess all aspects of ventilation safety and resilience required for the safe development and operation of healthcare premises. It should inform the following areas:

- the design process for new healthcare premises;
- the design process for modifications to existing premises;
- the commissioning and validation process;
- operational management and maintenance;
- annual verification and performance testing;
- prioritising the plant replacement programme;
- decommissioning and removal of redundant equipment.

Note:

Where estates and facilities provider services are part of a contract (including PFI), it is essential that these providers participate fully in all those aspects of estate and facilities management that can affect patients. This includes responding to specific requests from the VSG, which may be in addition to relevant guidance and documentation.

4.7 It is important that decisions affecting the resilience, safety and integrity of the ventilation systems and associated equipment are not taken without the agreement of the VSG. The VSG should ensure that appropriate expertise and competence is available when making such decisions.

4.8 Whenever significant building work is undertaken, the VSG should consider its effects on the existing ventilation system air intakes. These may need to be protected from airborne dust during construction by the fitting of temporary additional filtration. There will also be a need to identify any risks to construction personnel who may be working in the vicinity of extract air discharges.

4.9 When construction or alteration work is undertaken inside an occupied building, its effects on the occupiers should be considered. The VSG should be consulted, and they may require that the area be sealed off from the occupied parts of the building and that a temporary extract be provided to maintain the worksite at a

negative pressure to prevent the spread of dust into the rest of the building.

Derogations and alternative design strategies

4.10 Any derogations or alternative design strategies from this guidance should be subject to the scrutiny and agreement in writing by the VSG. The reason for the derogation or alternative design strategy and limits to its application should be recorded.

4.11 Designers proposing a derogation or alternative design strategy should be able to supply a body of evidence that their proposal will provide a degree of safety no less than if the guidance in this document had been followed.

Note:

The foregoing guidance is not intended to prevent the use of new technology or stifle design innovation but rather to ensure that what is being proposed will result in a facility that is fit for purpose when used. It will not be enough to state that the derogation or alternative design strategy proposed has been used elsewhere. There should be evidence that what is being proposed has been successful elsewhere.

Definition of clinical areas and critical systems

4.12 Healthcare ventilation may serve clinical or non-clinical areas of the estate:

- Clinical areas are defined as spaces within the building where surgical or medical treatment is administered to patients. This includes patient bedrooms.
- Non-clinical areas are defined as spaces where patients may be present but are not under direct treatment. It also includes staff and healthcare services areas.

4.13 Certain clinical and non-clinical areas within a healthcare establishment are considered critical to its ability to provide healthcare. Typically, ventilation systems serving the following are considered critical:

- operating suites of any type including rooms used for image-guided surgical procedures and their recovery areas;
- airborne isolation facilities, both source and protective;
- critical care areas and neonatal units;
- invasive treatment, endoscopy and bronchoscopy rooms;
- containment level 3 laboratory;
- pharmacy aseptic preparation facility;
- inspection, assembly and packing (IAP) room in a sterile services department;
- MRI, CAT and other types of emerging imaging technologies that require particularly stable environmental conditions to remain within calibration;
- any system classified as an LEV system under the COSHH Regulations;
- any other system that clearly meets the definition that “a loss of service from such a system would seriously degrade the ability of the premises to deliver optimal healthcare”.

Note:

If any doubt exists about whether a system falls within this definition, the VSG should be consulted regarding the risk to patient safety and business continuity.

Resilience and diversity

4.14 When planning the ventilation of healthcare facilities, it is important at the outset to consider how the service will be delivered if the installed ventilation system fails or the area served has to close due to the effects of fire, flood or an outbreak of infection. The loss of power, primary heating or cooling medium, or an integrated contol system can cause the loss of ventilation to an area, so subsystem resilience is an important consideration.

4.15 Resilience in critical healthcare areas can be provided by splitting the ventilation load between two or more AHUs and/or employing a design that allows two or more AHUs to feed a common plenum with isolation dampers on individual branches to each critical zone. (Note that it is not proposed that duplicate back-up units be provided.) As an example, a large critical care area (CCA) level 2 or 3 could be split into two sections with an AHU for each. A small CCA cannot easily be split, so a decant area with a suitable level of ventilation should be pre-designated.

4.16 Diversity can be achieved by having several facilities each served by its own AHU. As an example, in an operating department, if each theatre suite is fed from its own dedicated AHU, the loss of one suite, while inconvenient, will not shut the department. The same scenario applies to isolation rooms if several of them are each independently ventilated (see Health Building Note 04-01 for further information).

Note:

Providing twin ventilation fans in an AHU delays the time at which the system needs to be completely shut down in the event of a fan failure. It does not in itself provide resilience in terms of delivering healthcare (see Chapter 9 for further guidance).

New build facilities

4.17 New build healthcare facilities must be fully compliant with the requirements of all legislation in force at a date agreed when signing the contract. They should comply with the guidance contained in the current HTM unless a derogation has been agreed with the VSG (see paragraphs 4.10 and 4.11).

Assessment of service requirements: selection of design criteria

External design conditions

4.18 The most accurate data that is available for the summer and winter conditions at the site should be used. The Meteorological Office supplies data for the United Kingdom; data is also available from CIBSE and other sources. It is essential that the designer agrees with the client as to which source of data is used and the design risk associated with the chosen external design conditions.

Note:

It is essential to design to future climate projection to ensure design temperatures are maintained even in the event of prolonged heatwave conditions. CIBSE (2014) publishes design summer year weather files morphed to reflect future climate change.

4.19 Local adjustments for height above sea level, exposure factor, or other local climate peculiarities should be made as appropriate.

Internal design conditions

4.20 The design conditions selected within patient areas should strike a balance between the comfort requirements of staff and patients, who often have very different levels of clothing and activity.

4.21 Recommendations for the operative temperature and humidity of individual

spaces are given in Activity Data A-Sheets (see Chapter 8 for specific requirements). Particular departmental requirements are given in the respective HBN and room data sheets.

Minimum fresh air requirements

4.22 In general areas and wards within healthcare premises, odour control is the main reason for providing ventilation. In the absence of other guidance, 10 L/s/person should be taken as the minimum ventilation requirement. Healthcare ventilation systems will normally be "full fresh air" either by natural, mixed mode or mechanical means, with energy recovery from the extracted air.

4.23 In non-clinical areas recirculated air systems may be considered. At least 20% of the recirculated air should be fresh. Additional filtration will be required to remove airborne particulate contamination and, if necessary, odours. This will affect running and maintenance costs and, given the high ErP rating of heat recovery devices, it will be necessary to prove that recirculating the air will be more energy-efficient overall.

Note:

Ultra clean ventilated (UCV) operating theatres use air recirculation. The fresh air requirements of this specific application are given in Chapters 8 and 9.

4.24 Smoking is generally not permitted in healthcare premises, so no allowance need be made. Reference should be made to local national policy guidance.

4.25 In treatment and support areas the overriding requirement may be due to airborne infection control, hazard containment, the stability of specialist equipment or relate to a specific department's function. Each case should be considered independently in order to determine the overriding minimum requirement for ventilation (see Chapter 8 for specific guidance).

Limiting supply air conditions

4.26 For most applications in healthcare buildings, it is the temperature differential between the supply and room air, rather than the actual temperature of the supply air, which is the critical factor. The maximum recommended supply-to-room air temperature differential is:

- summer cooling: 7 K
- winter heating: 10 K.

4.27 Room air humidity should be kept below 70% in order to minimise risks associated with condensation and mould growth. There is no lower limit in unoccupied spaces.

4.28 Some types of diagnostic imaging technologies require close control of both temperature and humidity as well as the rate of change of conditions to ensure clarity of the image and accuracy of the data generated. The manufacturer's guidance should be followed.

Air purity

4.29 In healthcare premises, the standard of filtration will depend on the activities within the occupied spaces. Except for special areas (for example, manufacturing pharmacies), the requirement for aerobiological needs is not stringent and filtration is only required to:

- maintain hygienic conditions for the health and welfare of occupants, or for processes such as centralised food preparation facilities;
- protect finishes, fabrics and furnishings – to reduce redecoration costs;
- protect equipment either within the supply air system – to prevent

blocking of coils – or in the space itself to prevent dust accumulation.

4.30 Given that almost all viable particles will originate from the occupants of a space and not from the incoming air, dilution is the more important factor aerobiologically. Therefore, for general areas an ISO ePM 2.5 ≥55% filter may be suitable. More critical areas would require an ISO ePM1 ≥50% filter. Efficiency or high-efficiency (EPA or HEPA) filters will only normally be required in ultra-clean systems and designated "clean rooms" (see Chapter 9 for specific information).

4.31 In some inner-city areas the local airborne particulate level may be particularly high. In those special cases filters to ISO ePM1 ≥50% may be required to achieve the required indoor air quality. (See Defra's website and the Specialised Ventilation for Healthcare Society's (2018) SVHSoc.02 – 'Change in air filter test and classification standards'.)

Humidity control requirements

4.32 Close control of humidification was originally required for some healthcare applications (for example, operating theatres) in order to control the risk associated with the use of flammable anaesthetic gases. The use of such gases has now ceased.

4.33 Providing humidification is expensive in terms of plant, running costs and maintenance, and therefore its use should be restricted to where it is necessary for physiological or operational reasons (see Chapter 8 and associated HBNs).

4.34 In general terms the humidity within an occupied building or space will naturally float between 30% and 70% RH (relative humidity). Humidity should not be allowed to rise above 70% at any time but there is no need to maintain a background minimum level when the building or space is unoccupied.

Maximum noise levels

4.35 Noise will be generated in an air distribution system by the fan, ductwork fittings, dampers and grilles. The specified maximum noise level will depend on the activities within the occupied spaces.

4.36 Attenuation should be incorporated into the ductwork system or plant arrangement as necessary to reduce noise from fans and plant items in order to achieve the acceptable limits within the rooms at the design airflows.

4.37 Plantroom noise level from fans when starting up or running should not be greater than 80 dB(A), and should be reduced where the plant is near to departments sensitive to noise.

4.38 Attention should be given to the reduction of tonal components. High tonal components from air diffusers etc can seriously disturb concentration over longer periods even when the overall noise level is low. Broadband noise causes less annoyance.

4.39 The values recommended in Table 1 are for the total noise environment of space. In general, there will be noise transmitted into the space and noise generated within the space. The designer requires knowledge of the total hospital layout and operational policies, to assign acceptance magnitudes to all the possible noise sources, in order to arrive at the correct rating.

4.40 In Table 1 the overall noise level takes account of all internal and external noise sources. The noise level is the level measured with a sound-level meter in the unoccupied room, taking account of the external noise together with the noise generated by the ventilation system. The ventilation plant design noise level is that generated by the plant alone with no other noise source being considered. The levels suggested make recognised allowance for

Table 1 Interior noise level

Area	Room: overall noise level – dB(A)	Ventilation design value – dB(A)
Operating department all rooms including preparation, anaesthetic, scrub and utility, interventional and diagnostic imaging departments – all rooms	48	45
UCV operating theatre and adjacent open-plan scrub only	53	–
Treatment rooms Consulting rooms Sleeping areas/rooms Recovery rooms	35	32
Sanitary facilities	45	40
Aseptic preparation facility	45	40
Industrial areas	50	45
Circulation waiting areas	50	45
Plantrooms	85	80

the ingress of environmental noise which will have to be considered in the overall design, that is, in specifying the attenuation of walls, partitions, ceilings, etc.

4.41 The recommended criterion is measured as the "A" weighted sound pressure level expressed in decibels, which should not be exceeded for more than 10% of the time. See Health Technical Memorandum 08-01 – 'Acoustics' for further information.

4.42 The designer should also consider noise escaping to the external environment and this should not be unacceptable to occupants of adjacent buildings.

Calculation of building loads

Air infiltration

4.43 Air infiltration occurs due to a complex combination of wind pressure, thermal effects, location relative to other features and the construction standard of the building. The infiltration rate is governed by the size and number of doors and other openings in the building envelope and the complexity of internal air paths.

4.44 CIBSE guide TM52 provides information and formulae for the calculation of air infiltration in buildings. In all cases the requirements of the appropriate section of the current Building Regulations Part L (airtightness minimum requirements) must be met.

Summertime temperatures

4.45 To prevent overheating and avoid the future need for portable room air-conditioners, thermal modelling should be undertaken to ensure that internal temperatures in all areas do not exceed CIBSE Guide A guidance. Thermal modelling should be carried out whether the space is ventilated by natural, mixed mode or mechanical means. The modelling should be undertaken by a competent software user and take into account not only absolute values but also the time component.

4.46 Where thermal modelling indicates internal temperatures will exceed the recommended levels defined in CIBSE Guide A, additional measures should be explored to achieve compliance such as reducing solar and casual gains, improving building fabric performance, etc.

Peak heating load

4.47 Peak heating local calculations are necessary on all mechanical supply systems to establish the size of heater-batteries and subsequently the central plant. Note that with the introduction of the requirement to fit energy recovery set out in EU 1253, the heater-battery size will be reduced. If the energy-recovery value is ignored, the heater-battery and its control valve will be oversized and the system when put to use will be unstable and liable to hunt.

4.48 Where ventilation systems provide tempered air to spaces which have supplementary low pressure hot water (LPHW) to offset the building fabric losses, the AHU heating load should be calculated based on the external winter design temperature, the design internal air temperature, and the calculated total air volume (including a suitable allowance for leakage).

4.49 Where the ventilation system is the only means of heating a space, an increase in load equivalent to the calculated fabric heat losses from the space should be added to the ventilation load. A check of supply temperature difference should be made. If it exceeds that recommended in paragraph 4.26 the ventilation supply volume should be increased to suit.

Peak cooling load

4.50 In addition to the base data of airflow rates and temperatures, when calculating cooling loads, the designer should take into account:

- solar cooling loads;
- surface conduction cooling loads;
- internal gain cooling loads;
- air infiltration cooling loads;
- cooling loads due to high limit humidity control;
- method of control of internal conditions;
- fluctuations in internal temperatures.

4.51 When the peak internal loads have been assessed and a suitable allowance made for non-coincidence, the supply temperature can be calculated.

4.52 Once the lowest required supply temperature of the air handling unit has been established, and an allowance made for temperature rise through the fan and ductwork (usually 1 K for low pressure systems), the off-plant enthalpy can be established from a psychrometric chart or table.

4.53 The cooling loads for all plant on the chilled water system should be calculated at each of the individual peak times in order to accurately establish the required (diversified) capacity of the chiller.

Note:

Note that as with heating, the introduction of the requirement to fit energy recovery set out in EU 1253 means that the cooling-coil size will be reduced. If the energy-recovery value is ignored, the cooling coil and its control valve will be oversized and the system when put to use will be unstable and liable to hunt.

Annual energy consumption

4.54 The annual energy consumption of simple heating-only ventilation systems is simple to calculate, based on supply to external air temperature rise, and frequency of occurrence of external temperature data (see CIBSE Guide A).

4.55 Minimum air volumes are usually fixed by the room loads or fresh air requirements; however, the designer may increase airflow to some rooms or zones in order to balance loads, as detailed in paragraphs 4.63–4.68.

4.56 The method of zoning and control can significantly influence energy consumption.

4.57 The nature of air-conditioning operation, that is, cooling and reheating for humidity or zonal temperature control, makes prediction of energy consumption very complex. It is imperative that these calculations are performed to ensure optimum energy efficiency.

4.58 The concept of load and plant operation charts is outlined in the CIBSE Guide TM52. The method requires the designer to establish the minimum and maximum loads on all zones across the range of external temperatures between winter and summer design conditions. The total coil loads can be calculated taking account of the external air temperature and humidity plus the supply air conditions.

4.59 When all temperatures/enthalpies for all zones are plotted on the plant operation chart, set points and resetting schedules can be established. From this information, the outputs of individual heaters, coolers and humidifiers can be established at any given external condition. When those loads are computed against annual frequency of occurrence of external conditions as given in CIBSE Guide TM52, the annual energy consumption of individual elements, and thus the air-conditioning system, can be established.

4.60 In order to prevent surface condensation occurring, it is necessary to provide enough ventilation to maintain the maximum and ambient dew-point temperature below the lowest surface temperature, the coldest usually being the glazing.

4.61 Where this would require excessive ventilation levels, the designer should consider removal of the moisture at the source of the evaporation via an exhaust hood or similar device.

4.62 In intermittently heated buildings, it is necessary to consider the condensation risk at night set-back conditions as well as during normal operation. Calculation methods for this assessment are given in CIBSE Guide A.

Calculation of plant requirements

Air supply volumes

4.63 The minimum air supply volume for a room is determined by the greatest of:

- the minimum fresh air requirement;
- the air required to achieve the room differential pressure and provide open door protection at the key door;
- the minimum supply volume for the room load as determined by the maximum heating or cooling supply temperature differential;
- the desired air-change rate;
- the make-up air for a local extract (for example, cooker hood or LEV system).

Plant sizing

4.64 Once the design airflow has been established, the cross-sectional area of the air-handling unit can be calculated based on values given in Commission Regulation EU 1253/2014.

4.65 The fan duty should be calculated by adding the resistances of all elements that contribute to the pressure drop of the index circuit.

4.66 In order to establish the length of the AHU, it will be necessary to refer to manufacturers' literature, ensuring all necessary access panels and components are included as detailed in Chapter 9.

4.67 The designer should ensure that an allowance has been made for "dirty filter" conditions and confirm whether the fan

pressure quoted is the total or static pressure.

4.68 Upon completion of the resistance calculation exercise, the designer should make allowances for calculation and construction tolerances as indicated below:

Total pressure loss margin:

a. for leakage and balancing requirement = +5%

b. for uncertainties in calculation = +5%

Combined total pressure loss margin = +10%.

Note:

All installed ductwork whether new or reused should be subject to a leakage test on site prior to the application of any insulation. The leakage test should be to BESA DW144 but with a permissible leakage rate of not greater than 3%.

Refurbishment of existing facilities and fitting out shell schemes

4.69 When refurbishing existing facilities or fitting out "shell" schemes, every effort should be made to achieve full compliance with this HTM and current Health Building Notes (HBNs).

4.70 The physical constraints of the building may mean that some derogation in terms of layout and room dimensions are unavoidable, but it is vital that the infection control aspects, clean airflow paths, cascade of air from clean to less clean areas and fire and smoke requirements are not compromised and that the complete facility will be fit for purpose. The VSG should be consulted and agree in writing to any derogations.

4.71 A new AHU fully compliant with current standards will normally be required. The existing AHU should only be retained if it is not more than 10 years old and is (or can be made) fully compliant with current standards.

Note:

The application of the ErP regulations may mean that new plant could be physically larger than that previously installed. If the replacement plant cannot be accommodated in the existing plant space, the plantroom may need to be expanded or a new plant space created. It may be that reconsidering how the ventilation load is determined, whether it can be shared, which type of AHU configuration will fulfill the design need, etc, will provide a satisfactory solution rather than just specifying like-for-like replacement plant.

4.72 The most commonly used original standard operating theatre design solutions from previous versions of this HTM have been revised and updated (see Appendix 7). They have been retained in this guidance as they will remain applicable to older theatre suites that are being refurbished within their original footprint. They may also be applicable where a pre-built "shell" is being fitted out.

Change of use of existing facilities

4.73 When a change of use of existing facilities is contemplated, the ventilation requirement should be completely revised to suit the new use (see paragraph 4.63).

4.74 A new AHU fully compliant with current standards will normally be required. The existing AHU should only be retained if it is not more than 10 years old and is (or can be made) fully compliant with current standards.

4.75 If the ventilation load is to be increased or reduced and the existing system is retained, its output should be adjusted to suit. This will necessitate a recalculation of the heater and cooler loads and resizing of the control valves to match the new loads. It may also necessitate a change in fan size. Failure to carry out this exercise will carry an energy penalty and loss of control function.

4.76 The area/zone fire strategy should be reassessed to suit the new layout and purpose.

Computer-aided design (CAD) and building information modelling (BIM)

4.77 The design of new ventilation systems should be created using a CAD package, and the information generated should be incorporated into the BIM for the project. The client should have access to the BIM model as the project progresses; it will be transferred over to the client on completion (see paragraph 13.28 onwards).

5.0 Ventilation strategies

5.1 In order to reduce energy costs and provide a more sustainable healthcare estate and support the declared zero-carbon target, ventilation selection should be as follows:

- first choice – natural ventilation
- second choice – mixed mode ventilation
- final option – mechanical ventilation.

Natural ventilation

5.2 Natural ventilation is usually created by the effects of wind pressure. It will also occur if there is a temperature difference between the inside and the outside of a building. The "thermo-convective" effect frequently predominates when the wind speed is low, and will be enhanced if there is a difference in height between inlet and outlet openings.

5.3 Ventilation induced by wind pressures can induce high air-change rates through a building, provided air is allowed to move freely within the space from the windward to the leeward side. However, in most healthcare applications, internal subdivisions will restrict or prevent this effect.

5.4 Current guidance restricts the opening of windows for safety reasons; also, as many designs are top-hung, their ability to permit natural ventilation is limited. Some types of window (for example, vertical sliding) can enhance single-sided air change by temperature difference, and these will improve the overall rate of natural ventilation in protected or sheltered areas where the effect of wind pressure is likely to be minimal.

5.5 Current healthcare building design philosophy suggests that windows are provided to allow light into and a view out of a healthcare building. Ventilation should be provided by purpose-made openings with appropriate consideration for thermal comfort and air quality. The airflow may need to be controlled by motorised dampers linked to temperature and/or occupancy sensors in the ventilated space.

Note:

Natural cross-flow ventilation can provide reasonable air distribution for a distance of up to 6 m inwards from the external facade, provided that reasonably clear air paths are maintained. Beyond this distance – in areas where clear air paths cannot be maintained and in areas where high minimum air-change rates are specified – mechanical ventilation should be provided.

If natural ventilation is single-sided, it will usually only be effective for a

3 m depth within the space. Beyond that it should be supplemented by mixed-mode or mechanical ventilation.

5.6 With natural ventilation, it is almost impossible to maintain consistent flow rates and ensure that minimum ventilation rates will be achieved at all times. However, this variability is normally acceptable in non-clinical spaces such as office accommodation, staff areas, library/seminar rooms and dining rooms, and some clinical areas such as level 0 and 1 care spaces and waiting and consulting rooms where risk of airborne infections is likely to be low. Where it is essential to achieve a minimum ventilation rate at all times, mixed mode or mechanical methods will be needed.

5.7 Constraints caused by a building's shape and/or the functional relationships of specific areas will inevitably result in some measure of deep planning, thus reducing the opportunity for natural ventilation.

5.8 In all cases, for natural ventilation to be effective it will be necessary to take steps to reduce any solar gain to a minimum. Outdoor air-quality, excessive heat gain, indoor air-quality requirements or external noise are all factors that may limit or preclude the use of natural ventilation.

5.9 Further information can be found in Health Building Note 00-10 Part D – 'Windows', BS 5925 and CIBSE's Applications Manual AM10 – 'Natural ventilation in non-domestic buildings'.

Mixed mode ventilation

5.10 Mixed mode ventilation is an assisted form of natural ventilation. Fans are fitted in purpose-made damper-controlled ventilation openings. Alternatively, a separate draw- or blow-through ventilation unit may be installed. In both cases the dampers and fans are controlled by temperature and occupancy sensors to ensure a minimum airflow rate while taking advantage of natural ventilation effects when present.

5.11 Where natural or mixed mode ventilation is adopted with complex air paths, the designer should produce an airflow diagram in order to ensure correct provision of air-transfer devices. CIBSE's Applications Manual AM13 – 'Mixed mode ventilation' gives guidance. Modelling of the airflows under a range of conditions should be undertaken to establish the airflow paths.

Mechanical ventilation

Central versus local plant

5.12 Mechanical ventilation is expensive so it should only be provided when the space being served requires close control of its environmental conditions.

5.13 If the ventilation loads throughout a department or building are in phase, or are not significant, a central plant with single zone control may be adopted. However, this is rarely the case, so the condition or quantity of supply air to different areas or zones of the building will be varied accordingly. This may be achieved by either providing individual plant to each zone or providing separate controls for each zone such as provided by a variable air volume (VAV) system. Where there is a high density of rooms with similar ventilation requirements in an area of a building or department, it is usually economical to combine them into a central system; however, the operational resilience should be considered.

5.14 In large buildings, a choice between a small number of large ventilation systems located in centralised plant areas, or a larger number of smaller locally distributed systems, may arise.

5.15 Large distribution systems and their plant can have the advantage of lower capital costs, but because they operate to a fixed supply condition, reheating or cooling may be locally required which will reduce energy efficiency. The distribution system will require more space for vertical shafts. In general, very long runs of ducting should be avoided to prevent undue heat losses or gains, excessive leakage and difficulties in balancing during commissioning. As the pressure losses in the long runs will be greater and a higher initial static pressure will be required, this may lead to a more expensive class of ductwork.

5.16 Decentralised AHUs feeding multiple smaller distribution systems may be more expensive in capital costs but as they avoid long runs, large ducts and vertical shafts, this may reduce overall costs. They can provide a more robust service, as the failure of an individual system does not prevent the use of the rest of the building. Future refurbishment or replacement of AHUs is also simpler. See also Chapters 4 and 9.

Horizontal and vertical AHUs

5.17 AHUs may be configured as horizontal or linear units that are single or double-stacked in the case of combined supply and extract units. They may also be configured more compactly as vertical or cabinet-style units. Selection will be dependent on the plant space available and where the unit is to be located. Whichever style is selected, good access for service and maintenance is essential. See legal requirements in paragraphs 3.6 and 3.10.

Chilled beams

5.18 Active chilled beams can provide an energy-efficient means of controlling environmental conditions. They are, however, subject to increased maintenance requirements due to the need for regular cleaning if they are to remain working efficiently. Access for this will not pose problems in non-clinical and office areas, but in clinical areas and patient bedrooms, routine access will be a major problem in an operational hospital.

5.19 Chilled beams should not be installed in clinical areas without the agreement in writing of the VSG.

Note:

Patient bedrooms are classed as clinical areas as treatment is often delivered at the bedside rather than in a designated treatment room.

5.20 Where chilled beams are installed in non-clinical areas, they should be positioned to ensure that cold draughts are avoided.

5.21 In order to avoid condensation on the beam coils and the potential for mould growth, the temperature of the secondary chilled water circuit needs to be kept above dew-point (usually 15°C). With active beams the supply air may, under some outside air conditions, need to be dehumidified. Manufacturers of these devices can provide specific advice on the design limits and siting of their equipment.

5.22 Where chilled beams are installed in rooms with opening windows, the window should be fitted with a switch to automatically turn off the beam when the window is open. To avoid condensation, chilled beams should not be installed in entry lobbies that directly connect to the outdoors.

5.23 Active and passive chilled beams require regular cleaning if they are to remain efficient. They should be of a design that allows full access to the beam coils for cleaning and be positioned where they will be accessible for maintenance and not installed above fixed items of equipment.

5.24 There is no benefit in installing chilled beams if the resources to keep them in efficient working order over their entire life cycle will not be available. The maintenance aspects of using chilled beams should be discussed and the decision to use them agreed in writing with the client.

Note:

Maintenance access to chilled beams will require the use of pulpit steps or wheel-around access equipment. The use of such equipment in a working hospital is very restricted.

Stand-alone air-conditioners

5.25 Stand-alone air conditioners include fan coil units, split-comfort air-conditioners, room conditioners and cassette units. All of these devices recirculate air which affects indoor air quality and may increase the risk of healthcare-associated infections (HAIs). Therefore they should not be installed in clinical areas.

Note:

Patient bedrooms are classed as clinical areas as treatment is often delivered at the bedside rather than in a designated treatment room.

5.26 Stand-alone air conditioners may be installed in suitable non-clinical areas, but they should be positioned to ensure that cold draughts are avoided. The control settings should ensure that the external elements of the units are always above dew-point. Manufacturers of these devices can provide specific advice on the siting and design limits of their equipment.

5.27 Stand-alone air-conditioners recirculate air, therefore, a primary fresh air supply of at least 20% of the room air-change rate, or that required by the Building Regulations, or 10 L/s/person – whichever is the greatest – should be provided.

5.28 Whether single or multiple systems are used, it is essential that the designer give due consideration to the source of electrical supply, location of the heat rejection unit, environmental effects and flammability of the refrigerant used, and drainage provision for the cooling-coil condensate.

5.29 Stand-alone air conditioners require regular cleaning if they are to remain efficient and not become a source of airborne bio-hazards. If they incorporate an open water drainage system, they must be risk assessed under L8/HSG274 as part of the *Legionella* assessment (see the Health & Safety Executive's (HSE) Approved Code of Practice and guidance document HSG274 'Legionnaires' disease: the control of *Legionella* bacteria in water systems'). They should be easily accessible for maintenance and should not be installed above fixed items of equipment which would make access difficult.

Notes:

1. Maintenance access to stand-alone air-conditioners will require the use of pulpit steps or wheel-around access equipment. The use of such equipment in a working hospital is very restricted.

2. Traditional refrigerants are being phased down because of their effects on the environment and are becoming ever more expensive. Their replacements at the time of writing have a degree of flammability. Both these factors pose serious consideration as to whether stand-alone air-conditioners are suitable devices to choose. In scanning and control equipment rooms, the use of chilled racks, shelves and embedded panels supplied with water above dew-point would be a more suitable option.

System selection

5.30 Natural ventilation is always the preferred solution for a space, provided that the quantity and quality of air required, and consistency of control to suit the requirements of the space, are achievable. If this is not the case, mixed mode or a mechanical ventilation system will be required.

5.31 Ventilation costs can be minimised by ensuring that, where practicable, core areas are reserved for those rooms that need to have mechanical ventilation. Examples are:

- sanitary facilities, dirty utilities and those rooms where clinical or functional requirements have specific environmental needs; and
- those rooms where – for reasons of privacy, absence of solar gain, etc – windowless accommodation is acceptable.
- Other spaces appropriate to core areas are those which have only transient occupation and therefore require little or no mechanical ventilation (for example, circulation and storage areas).

Zoning of the building

5.32 The efficiency and effectiveness of any ventilation or air-conditioning installation depends largely on the zoning and control of the installation. The factors to consider when determining the zoning of a ventilation system for a building or department are:

- periods of occupancy;
- the service delivery resilience;
- fresh-air/ventilation requirements;
- the fire and smoke control strategy for the area.

5.33 Where the ventilation system is not merely tempering the air, but also providing the heating and/or cooling requirements (air-conditioning) the following additional factors should be considered:

- internal or peripheral location;
- orientation of windows;
- variation of internal loads;
- level of control required.

5.34 For single-zone plant in staff areas, local control (with a run-on-timer if required) is recommended, as the system can be turned off when the space is not in use, thus saving both thermal and electrical energy. Most clinical-zone supply and extract systems, conversely, are required to operate continuously while the department is occupied; thus some form of time or use control is necessary.

5.35 The control of individual plant items is covered in Chapter 9, with examples of typical control strategies in Chapters 6 and 7. For control parameters of particular critical ventilation and air-conditioning systems, see Chapter 8.

5.36 On rare occasions a duplicate standby air-handling plant may be justified. If installed, it should be provided with a gas-tight damper (see BS EN 1751) at its junction with the supply distribution duct so that no back-flow can occur. Standby plant can become sources of contamination if warm, moist air is allowed to dwell within them. Their design and control system should ensure that this cannot happen.

Note:

The presence of duplicate plant should be reflected in the fire strategy.

Fire and smoke control

5.37 Within a designated departmental fire zone, the total mechanical supply and extract ventilation volumes should be approximately equal so that in the event of a fire, smoke is neither drawn into nor blown out of the zone. Note that individual sub-zones within the departmental zone may be positively or negatively pressured to suit the clinical need (for example, isolation rooms, operating theatres).

Note:

In atria, stairwells and designated escape routes, dedicated smoke clearance fans may be installed to keep evacuation routes clear in the event of a fire. These together with their associated smoke dampers do not form part of the building's general ventilation system and their operation will be automatically initiated by the building's fire detection system and/or manually controlled by fire service personnel (see Health Technical Memorandum 05 Firecode).

Air-conditioning

5.38 Air-conditioning is the facility to filter, heat, cool, dehumidify and if required humidify the supply air to maintain an internal condition regardless of changes in the external conditions or internal load. It is expensive in plant and energy.

5.39 Due to capital and running costs, air-conditioning should only be used in essential areas. These include operating departments, critical care areas, manufacturing pharmacies and areas with particularly sensitive equipment. Information on system performance requirements for individual departments is given in Chapter 8.

Local exhaust ventilation

5.40 There is a statutory requirement under the COSHH regulations to prevent or control the escape of chemicals, toxic fumes, biological materials or quantities of dust into the general environment. For airborne hazards to people, control may be by the provision of an LEV system designed to the standard set out in HSG 258.

Ventilation for general areas

5.41 Chapter 8 and Appendix 2 provide recommended air-change rates, temperatures and pressures for general areas requiring mechanical ventilation in healthcare buildings.

Mechanical extract ventilation

5.42 General extract systems can vary in complexity from a single wall-mounted fan to a central ducted air system with dual extract fans.

5.43 Replacement air is provided by either a central supply system or enters the building through gaps in the structure or purpose-made openings. The design should ensure that the latter does not result in an unacceptable level of draughts occurring in winter.

5.44 If individual systems are used, the ventilation can be operated intermittently, provided it continues to run for at least 15 minutes after the room is vacated (as with light-switch-operated fans in individual toilets).

5.45 If general exhaust systems are used, filtered and tempered replacement air should be provided to adjoining lobbies or corridors, to prevent the risk of discomfort caused by the ingress of cold air. Fire compartmentation requirements should be maintained.

5.46 Information on specialised extract systems is given in Chapters 8 and 9.

Mechanical tempered-air-supply systems

5.47 Where mechanical supply systems are required, the fresh air should be tempered and filtered before being delivered to the space in order to avoid discomfort.

5.48 The majority of space air temperature heating load will be provided by the energy-recovery device with the balance from a constant or variable temperature battery. In most instances, the low pressure hot water (LPHW) heating system should offset any fabric loss so that set-back room temperatures can be maintained during unoccupied periods without the need for the ventilation system to operate.

Balanced ventilation

5.49 A balanced ventilation system is a combination of both a supply and an extract system of equal volume; either a single space or a whole building may be considered to be balanced.

5.50 A balanced system is necessary in instances where it is essential to maintain consistent air movement within an area (for example, recovery rooms).

Cascade ventilation

5.51 In operating departments, it is normal practice to supply air to the operating theatre and allow it to flow through less clean areas – corridors, utility rooms, etc (from where it is eventually extracted). Pharmacy aseptic preparation facilities, maternity delivery rooms and treatment rooms are similar.

5.52 In negative pressure facilities it will be necessary to provide make-up air in order to promote the correct pressure cascade from the clean to the less clean (for example, supply in an outer area – to lobby – to patient's room – to toilet extract). Infectious diseases units and bronchoscopy rooms are similar.

Recirculation systems

5.53 Air recirculation systems are normally used in HEPA-filtered clean rooms where the return air is significantly cleaner than the outside supply and where odour levels are not significant.

5.54 Recirculation is also routinely used in the canopy section of ultra-clean operating theatre ventilation systems (UCV). The recirculated air is EPA filtered to ensure that biological contaminants released by the surgical team are not discharged back into the clean zone.

5.55 Recirculation may also be used for swimming and hydrotherapy pool ventilation.

5.56 Where the designer is considering the installation of an air recirculation system, due account should be taken of:

- a 20% minimum fresh air supply volume or that required by the Building Regulations or 10 L/s/person, whichever is the greatest;
- prevention of supply air contamination from vitiated return air;
- prevention of stratification occurring within plenum chambers and mixing boxes, which may result in freezing of downstream coils;
- ensuring sufficient velocities through automatic control dampers (ideally 5–6 m/s) where fitted, to provide suitable authority and good shut-off;
- modulating control of mixing to provide optimum on-plant conditions;
- the use of "free cooling" by cycling the dampers to minimum fresh air when the enthalpy of the outside air

is greater than that of the extract air under conditions when cooling is required.

Note

Recirculating air can create particular problems when its ductwork breaches fire compartmentation. Designers should ensure that the system complies with the fire strategy in all modes of operation.

Dilution ventilation and clean airflow paths

5.57 In the past dilution ventilation has been used as the sole means of controlling levels of airborne hazardous substances in a space. This approach in itself is no longer considered acceptable. COSHH requires that airborne hazardous substances should be controlled at source by using a closed system (such as an anaesthetic gas scavenging unit) or a protective enclosure (such as a fume cupboard). A good level of background ventilation will assist in diluting any casual release of the substance.

5.58 In anaesthetic rooms, the casual exposure of staff to leakage or spillage when administering anaesthetic agents should be dealt with by establishing a clean airflow path. Air should be supplied at high level above or behind the area where the staff will typically stand and extracted at low level directly behind the anaesthetic equipment position (see Figure A8 and photographs in Appendix 9).

5.59 The philosophy of establishing a clean airflow path – from the air-supply point, past the breathing zone of the staff, on to the patient or other source of airborne hazard, and out via a low-level extract – would also apply in recovery rooms, birthing rooms, bronchoscopy rooms, laboratories and post-mortem rooms. A suitable air-change rate (see Chapter 8) will provide background dilution ventilation as an additional safeguard. This approach ensures that regarding the ventilation aspects, "all reasonable steps are taken to prevent or control exposure (of staff) to the hazardous substance" as required by COSHH.

Note:

In these areas the supply air should be 100% fresh and not recirculated.

5.60 In operating theatres, patients will be on a closed breathing circuit in a room with a high air-change rate. Under these circumstances, the dilution effect would be considered sufficient to control any casual exposure of staff to anaesthetic gases.

Displacement ventilation

5.61 Displacement ventilation introduces air at low level and removes it at high level. It uses the natural thermal buoyancy resulting from heat gain to achieve air movement throughout a space with minimal or no energy input. Displacement ventilation can be natural, mixed mode or mechanical with the supply untreated, tempered or fully conditioned depending on the application.

5.62 Displacement ventilation can be very energy-efficient and works well in applications that have significant casual heat gains from solar effects, people or equipment. Typical applications in a healthcare setting would be the ventilation of atria, central dining rooms, main kitchens, hydrotherapy pools, computer server rooms, lecture theatres and open-plan waiting or office areas. It is also applicable to non-interventional imaging and scanning suites where there are significant equipment-generated casual gains but no aerobiological infection risks.

5.63 Supply terminals will be located at low level, usually in the form of large perforated plate style diffusers mounted

vertically. The supply air terminal face velocity is low so that it does not create draughts. It is essential that they are located in several positions so that they can ventilate the entire space. Care should be taken to ensure that fixed or movable equipment and devices cannot obstruct them. Extract will be at high level through vents or by a ducted extract system. The ventilation rate may be controlled by temperature or CO_2 sensor-initiated motorised dampers with or without fan assistance at the extract points. The supply air volume is then slaved to match.

6.0 Energy control strategies

6.1 The operation of ventilation systems should be monitored through a building management system (BMS). The basic objective should be to provide the necessary service utilising the minimum energy. To this end, switching a system "Off" when not required is the most energy-efficient policy.

6.2 If the system is needed to maintain a minimum background condition, reducing its output by "Setting back", to the minimum necessary to achieve and maintain the desired condition, is the next best option.

Note on "Set back":

In previous times when fan motors only had two speeds, turning the system to "Set back" meant switching to the lower fan speed. With modern fans the speed is widely variable so "Set back" is not a fixed fan speed but rather a control strategy that reduces the system output in order to maintain a desired minimum condition. This may be related to the air velocity at a fixed point, air-change rate, pressure differential, temperature, humidity or a combination of these parameters. Providing a dew-point sensor in an internal space that brings the system on to "Set back" is a simple way of maintaining a minimum condition.

6.3 The system should only run at full output when needed to achieve and maintain the defined "in-use" operating condition

6.4 Care should be taken when specifying plant to discover the true "in-use operating condition". Overstating the condition will lead to oversized plant, unstable control and excessive energy consumption.

6.5 The design and selection of set points for an AHU and associated extract system will have a significant impact on the overall energy consumption and efficiency of the system as a whole (see Chapter 9 for detailed information).

Timed control

6.6 Switch the AHU "On" and "Off" at fixed times using a time clock or BMS programme. The AHU needs to come on early enough in the morning to bring the space up to temperature by the normal start time.

6.7 As above but with an "Optimum start" control that uses the outside temperature to determine the start time. In the winter, the lower the outside temperature, the earlier the AHU starts. In summer, the higher the outside temperature above that desired, the earlier the AHU starts.

6.8 As above but link the AHU to a temperature sensor in the space. If out of hours the temperature inside drops to the dew-point, typically 16°C in winter, or rises above 25°C in summer, the AHU will start and run at "Set back" (see definition in the Note after paragraph 6.2).

6.9 Any combination of the above or any other appropriate and applicable method that uses the least energy to maintain the specified condition is valid. Various options for the control of single- and multi-zone air-conditioning systems are given in CIBSE Guides F and H.

Occupancy control – user triggered

6.10 The ventilation system output should be linked to occupancy detectors. These may take the form of movement, CO_2, passive infrared (PIR) or other sensing technologies that can detect that the area served is in use and switch the system "On" or "Off" and/or adjust the ventilation output to suit the actual load.

6.11 In intermittently used spaces such as operating suites, movement sensors (for example, PIR or similar) should be installed in the space with a "double knock" program so that if movement is detected twice within 10 minutes the AHU will switch "On" to full speed. If no movement is detected for 30 minutes, the AHU switches "Off". Double-knock detection prevents the system from switching on in situations where a person has briefly entered a space when it is not in use.

6.12 The above may be combined so that if there is no movement for 15 minutes, the AHU switches to "Set back" (see definition in the Note after paragraph 6.2) during the working day and "Off" outside of normal hours.

Note:

In Ultra Clean Ventilated (UCV) operating theatres the UCV terminal should be linked to the AHU control so that when the AHU goes to "Set back" the UCV also goes to "Set back", and if the AHU goes "Off", the UCV terminal fans also switch "Off". There is no aerobiological benefit in keeping the UCV terminal fans running when the theatre is not in use, it results in wasted energy.

6.13 An alternative strategy in operating suites is to link the AHU control to the lighting. If the theatre general lights are switched "On" the AHU switches "On" in "Set back" mode. If the main operating lamp is then switched "On" the AHU goes to "Full speed". If all the lights are out the AHU goes "Off".

Note:

There are occasions when this approach may need to be used with caution; for example, if a type of surgical procedure requires the operating or general lights to be "Off" during a part of the operation, an override timer or plant extension switch will be needed. The operating department manager and VSG should be consulted for approval before adopting this strategy.

User control

6.14 Some applications require intermittent mechanical ventilation, frequently at a high air-change rate (for example, in certain types of treatment room for odour control). Local controls to facilitate this mode of operation if required should be placed in a prominent position to encourage economical use. Specifying timers that shut the system down after a suitable operating period and need to be reset manually will reduce energy waste.

6.15 Local controls that enable the user to select more than one mode of operation should be clearly labelled to identify the particular mode selected.

6.16 Where the system allows different room pressures to be selected, a direct-reading pressure gauge should be fitted within the eyeline of the users, 1.5 m above floor level, adjacent to the selector control unit to provide an independent confirmation of the resultant mode of operation. A permanent notice giving a clear description of the selectable modes of operation should be mounted adjacent to the control unit.

7.0 Environmental control

Building construction factors

7.1 The primary objective of a ventilation control system is to keep the space served within the required environmental control limits, at the appropriate times – regardless of external conditions or internal loads – and with the minimum energy consumption.

7.2 The building heating load will normally be met by a wet heating system with ventilation provided to suit the activities within it. The control of the heating system will normally be compensated to the outside air temperature. Control of the ventilation will usually be via a building management system (BMS) with "outstations" in individual plantrooms and/or for individual AHUs.

7.3 A BMS incorporating self-adaptive control algorithms that automatically adjust the set-point to suit the usage and load is preferred. This will enable the operating conditions and control tolerances to be set and monitored. It is often not possible to accurately predict building load variation at the design stage. Information provided by monitoring the operation of the plant via a BMS will enable optimum set-points to be established and energy consumption reduced.

7.4 The BMS may also be set to log the actual energy consumed by the system together with that recovered by the energy-recovery device. This will provide a useful check on overall operating efficiency and provide evidence that energy targets are being achieved. The provision of movement sensors within the controlled space in order to determine the actual occupancy will facilitate this process.

7.5 The failure of ventilation systems serving critical areas can have grave consequences for the delivery of healthcare. Control systems should therefore be simple, robust and reliable.

7.6 Computer-software-driven control systems are now the norm in building services. However, healthcare ventilation systems need to be available for operation outside of normal working periods when software support is not available. Should the software fail, it will be left to site staff, who may have little knowledge of the control algorithms, to restart the ventilation system. It is therefore essential to ensure that a simple means of restarting critical systems in the event of a software failure is provided (see also Chapter 9).

7.7 Where BMS use "outstations" to control plant, the "outstation" should be independently able to control the plant if the BMS link is lost.

Location of controls

7.8 Whether within the plant, duct or room, sensors should be located to provide accurate measurement of the condition of the air being monitored.

7.9 Sensors and control items such as control valves should be located close to the element being sensed or plant item being controlled in order to minimise time lags within the system. These may create over-shoot of conditions beyond the design envelope and result in additional energy consumption.

7.10 Where there is a requirement for close control of air-conditioning parameters in a number of zones (for example, an operating department), separate plant should be provided for each zone in order to avoid the need for expensive over-cooling and reheating of individual zones. The control of most multi-zone systems within healthcare premises is based on off-coil control within the central plant, with trimmer heater-batteries on individual zones.

Note:

In modern buildings the cooling load is often significantly greater than the heating load and may exist all year round. Whenever possible, the design should take advantage of free cooling when available.

7.11 Facilities to start, set back and stop the plant should be provided in the plantroom. Remote start and set-back control and indication, if required, should be provided at a manned staff location (for example at the reception or staff base).

7.12 Many ventilation systems may be completely shut down when the area served is not in active use (for example, operating suites). Alternatively, where there is a need to maintain a background condition, the ventilation output may be reduced by "setting back" the system (see paragraph 6.2 and associated Note). This will significantly reduce energy consumption and extend the life of filters and other system components.

Multi-zone control methods and application

7.13 Close control of all air-conditioning parameters may be difficult to achieve with multi-zone systems, since each zone will in theory require a reheater and humidifier to give total control of humidity, if that is what is required. In reality, such close control is rarely required. It is therefore usual with multi-zone systems to provide control of zonal temperature only, with humidity control, where fitted, being based on average conditions within all zones, or a minimum condition within one zone.

7.14 Designers should consider whether it is necessary for the supply and extract fans to be interlocked – either so that the supply fan will not operate unless airflow is established within the extract system, or vice-versa depending on the required pressures within the rooms being served (see also Chapter 8).

7.15 The sequence switching of units in order to prevent transient reverse airflows will be particularly important in laboratories and pharmacies that contain fume cupboards, safety cabinets and other LEV systems.

Fire aspects

7.16 The control strategy for ventilation systems in the event of a fire should be set out in an agreed fire and smoke control strategy for the site (see Chapter 1).

7.17 All supply AHUs should have a smoke sensor linked to the fire control panel and mounted in the main supply duct immediately downstream of the AHU. In

the event of a fire in the AHU or smoke being drawn into the system from an outside source, it should cause the AHU to shut down and the main supply-air damper and system fire damper(s) to close.

7.18 In critical areas a ventilation control panel should be mounted at the main entrance of the area that the ventilation serves (see Health Technical Memorandum 05-02 for more detailed guidance). Access to the panel should be restricted to the fire officer and appointed site AP(V). It should include independent on/off controls and an indication of the status of the supply and extract systems. A notice should be affixed to the control panel stressing the need to liaise with departmental staff before switching off fan units

Note:

In certain critical care areas, it is preferable to maintain the supply ventilation in case of a fire within the area. For example, in an operating department, while undergoing surgery, the patient cannot always be easily moved without significant risk. In the event of a fire in a staff or support area of the department, or adjoining zone, the continued supply of air to a theatre will maintain it at a positive pressure and protect the patient and staff from the effects of smoke. This will allow time for the patient to be stabilised so that they can be safely evacuated if necessary.

User requirements

Room temperature control

7.19 The limits for room temperature set-point are generally between 18°C and 22°C depending on the particular application. In some specialised applications (for example, operating departments), the user may require a wider range of adjustment (see Chapter 8).

7.20 The selection of temperature set-point for each room or zone may be by a control facility in the room/zone or be carried out remotely at the control panel or BMS. Where the control device is mounted within the room/zone and is adjustable by the user, it should be marked either “raise” and “lower” or “+” and “–”. It should control within a specified temperature range to suit the user requirement with a control tolerance of ±1 K. All other control set-points should be selectable either on the control panel or at the BMS interface.

7.21 Where local control is provided, an indication of temperature will be required locally or at a staff base (if appropriate) using an analogue or digital indicator. The indicator should be large enough to be read from the normal working position (for example at the operating table in a theatre). This may be mounted in a supervisory control panel, with the signal repeated on the main system control panel or BMS. It is important that this indicator displays the actual measured temperature and not the selected temperature.

Alarms and indication

7.22 Supply and extract systems should include indicator lamps on the control panels to confirm the operational status of each system. Where the usage is on a regular daily pattern, time control with a user-operated, timed manual override should be provided.

7.23 Where a system is provided for a particular space, the indicator should be in, or immediately adjacent to, that space, and local controls should be provided with permanent labels clearly defining their function (for example isolation suites).

7.24 If room differential pressure gauges are required, they should be mounted directly adjacent to the entry door of the room to which they apply at a height of 1.5 m above floor level so that they are in

the eyeline of staff entering the room. If a mechanical gauge is fitted, it should have a green sector to indicate the acceptable normal pressure range. If electronic, it should have a permanent label affixed underneath it giving the normal acceptable pressure range.

For specific departmental control parameters, see Chapter 8. For plant controls see Chapter 9.

8.0 Specific healthcare department requirements

General considerations

8.1 The foregoing chapters of this document contain general information on healthcare aspects of ventilation system design and specification. This chapter gives information relating to the specific design requirements for a range of healthcare applications.

8.2 The following departments will require a degree of ventilation appropriate to their function.

- the operating department;
- treatment rooms, endoscopy and minimally invasive suites;
- critical care area – levels 2 and 3;
- diagnostic and interventional imaging and cardiology suites;
- obstetrics/maternity;
- infectious diseases unit and isolation facilities;
- bone marrow and other transplant units;
- chemotherapy and oncology units;
- the pharmacy department;
- the pathology department, mortuary and post-mortem suite;
- sterile services departments;
- burns unit;
- cystic fibrosis unit;
- tissue bank, gene therapy and emerging treatment specialties;
- physiotherapy and hydrotherapy;
- estates infrastructure.

Design information for many of these applications is given below, in Appendix 2 or the relevant HBN.

8.3 It is not possible to give definitive guidance for every healthcare ventilation application; however, the section on operating theatres contains much information that is common to other applications. Where no specific guidance is given, the principles set out below should be followed:

- The CIBSE guides and technical manuals contain basic information on ventilation design that can be applied to most applications.
- Where a British or European standard exists that is specific to the application

(for example, a clean room), it should be used as the basis of the design requirement.

- Air should always move from clean to less clean areas. A hierarchy of room cleanliness is given in Appendix 3.
- Differential pressure will prevent contamination between areas when doors are closed. Information on air leakage through gaps around closed doors and hatches for a range of differential pressures is given in Appendix 4.
- The flow of air will prevent contamination between areas of different cleanliness when doors are open. Information on airflow through open doors and hatches is given in Appendix 5.
- A methodology for calculating a design solution for a non-standard operating suite in terms of its room sizes, layout or number of people present is given in Appendix 8. This may be adapted as necessary to suit other less complex applications where air is required to cascade through rooms from clean to less clean areas.

Note:

In all cases it is essential that the design solution adopted will ensure adequate scouring of the space being ventilated. The selected airflow rates, relative position of supply terminals, extract terminals, air transfer devices and pressure stabilisers will all have a bearing on the effectiveness of the room ventilation.

8.4 There are four routes by which airborne contaminants may appear in a room:

- shed directly by the room occupants;
- arising as a result of the work activities;
- transferred from adjacent spaces;
- through the supply air.

Particles shed directly by the room occupants can be controlled by:

- restricting access to essential persons only;
- the choice of the occupants' clothing;
- the room air-change rate.

Particles arising as a result of the work activity can be controlled by:

- enclosing, semi-enclosing or otherwise controlling the work-based source;
- the room air-change rate.

The transfer of particles from adjacent spaces can be controlled by:

- a differential pressure between spaces when doors are shut;
- airflow paths flowing from clean to less clean spaces when doors are open.

Particles entering with the supply air can be controlled by the selection of a suitable filter.

When designing ventilation for a healthcare application, the sources of airborne contamination, their degree of hazard to patients and/or staff and the ability of ventilation to control them should be taken into account. For any particular healthcare application, the ventilation safety group (VSG) should be able to give advice on any specific risks to patients and staff.

8.5 The supply of air to a room has the following main functions:

- to dilute airborne contamination;

- to control air movement within such that the ingress or discharge of airborne contaminants from or to adjacent areas is minimised;
- to control the temperature and, if necessary, the humidity of the space;
- to aid the removal of and dilute fumes, odours and waste gases.

8.6 The supply air volume flow rate for any particular application will be that required to:

- achieve the application's recommended air-change rate;
- provide closed and/or open-door protection;
- achieve comfort or application-specific room conditions;
- replace (make up) that removed by an installed extract system;
- meet the fresh air requirement relating to the number of people anticipated to be present;
- achieve the minimum fresh air requirement if air is recirculated.

Whichever is the greatest amount.

Note:

Air-change rates are given in Appendix 2. These figures have been found to give enough dilution of airborne contaminants, provided the mixing of room air is reasonably uniform. Closed and open door protection volumes are given in Appendices 4 and 5. Fresh air requirement is at least 10 L/s/person. Minimum fresh air volume if recirculated is 20%, whichever is the greater.

8.7 Natural and/or mixed mode ventilation should be used wherever possible. Where mechanical ventilation is chosen, a downward displacement turbulent air distribution is generally preferred, though displacement ventilation may be used if appropriate.

8.8 The supply and extract terminals should be positioned to ensure that all parts of the room are actively ventilated and that where necessary the staff will be in a clean airflow path. Extract and air-out paths via door gaps, transfer grilles, pressure stabilisers and low-level active extract should be evenly distributed to encourage efficient scouring of the room. (See paragraphs 8.37–8.40 and 9.161–9.172 for additional guidance on location and types of terminal.)

8.9 Horizontal flow room air distribution with or without a coanda effect (see paragraph 9.162) can be a source of draughts and difficult to set up correctly. Its use should be confined to non-critical areas or situations where ceiling-mounted diffusers could be obstructed by movable equipment support tracks (for example, in imaging rooms). Alternatively, a displacement ventilation scheme may be considered.

Temperature and humidity control

8.10 Supply flow rates to achieve the required room conditions are calculated conventionally, taking account of all heat and moisture gains and losses, and of maximum permissible temperature differences between the room and supply air. In most applications the base heating load will be provided by a heating system. In critical systems the room or suite being considered will be within the heated building envelope so the ventilation will be sized to suit the casual gains or losses.

8.11 Temperature differences between supply and room air of up to 10 K for winter heating and 7 K for summer cooling should not be exceeded.

8.12 Room air humidity should be kept below 70% in order to minimise risks

associated with condensation and mould growth. There is generally no lower limit in unoccupied spaces; however, see application-specific guidance.

Ventilation where anaesthetic agents are present

8.13 During treatment, anaesthetic gas or anaesthetic agents may be delivered to the respiratory tract of a patient either directly or using a carrier gas. Anaesthetic gases and agents are subject to workplace exposure limits and while beneficial to the patient are harmful to staff. Waste anaesthetic gas should be contained and removed by a suitable anaesthetic gas scavenging system (AGSS). Some leakage from the anaesthetic equipment and the patient's breathing circuit will occur with all systems, particularly during connection and disconnection and from the interface with the patient. In recovery areas the patient will exhale the anaesthetic agent directly into the room air. The room ventilation scheme should ensure that any leakage or exhaled anaesthetic agents are diluted and removed.

Note:

Staff tend to be standing and patients lying down when anaesthetic agents are delivered; also anaesthetic agents are slightly heavier than air, so locating the supply terminal at high level behind where staff normally stand, with an extract at low level adjacent to the source (for example, the anaesthetic gas terminal units), will ensure that staff are in a clean airflow path.

8.14 The design primary air supply to an operating suite anaesthetic room that is equipped with a N_2O terminal or in which an anaesthetic agent is delivered to the respiratory tract of a patient using a carrier gas, or an operating department recovery room, should be 15 ac/h.

8.15 In delivery rooms the intake of anaesthetic gas is controlled on demand by the patient, who will then exhale directly into the room air. Locating the supply air at high level at the foot end of the bed with extract at low level at the head end will establish a clean airflow path and reduce the casual exposure of staff to the waste gas.

8.16 The primary air supply to any other room that is equipped with a N_2O or N_2O/O_2 (Entonox) terminal or in which an anaesthetic agent is delivered to the respiratory tract of a patient using a carrier gas or in which the patient is subsequently recovered, where the anaesthetic is employed for the purpose of pain relief or sedation but not full anaesthesia, should not result in less than 10 ac/h.

Note:

Staff employed in operating suite anaesthetic rooms and an operating department recovery room will potentially be exposed to anaesthetic agents for the duration of their working day.

In other areas (for example, maternity, imaging, treatment rooms), anaesthetic agents are only used for pain control and/or sedation. The strength, quantity and frequency of use will be significantly less, hence the difference in design air-change rate.

Door protection

8.17 Air should flow from the cleaner to the less clean areas as shown in Appendix 3 and Figure A6 in Appendix 8. There are several factors that affect the likelihood of a reverse airflow through doorways:

- When a person passes through a doorway, both the passage of the person and the movement of the door

flap cause a transfer of air between the areas separated by the door.

- When a door is left open, there is a transfer of air between the two areas separated by the doorway. This is caused by air turbulence, but is greatly increased by any temperature differential between the areas (a 1.4 m wide doorway may allow the transfer of 0.19 m^3/s of air in each direction when there is no temperature difference, but when the temperature differential increases to say 2 K, the volume transferred may increase to 0.24 m^3/s). This may be a problem if for example the heat gain from a fluid warming cabinet is not allowed for.

8.18 In order to reduce the likelihood of contamination of a clean area by a reverse airflow from a less clean area two methods of door protection are used:

- Closed door protection – a pressure differential is created across a closed door so that any air leakage is from the clean to the less clean area. Appendix 4 gives details of closed door leakage rates for a range of differential pressures.
- Open door protection – the pressure differential drops when a door is opened (see Appendix 6) and is effectively replaced by a flow of air through the doorway from the clean to the less clean area. The flow of air needs to be sufficiently large to ensure that significant reverse airflow cannot occur and will be related to the relative cleanliness of the areas being considered. Appendix 5 gives airflow rates for open-door protection related to door/opening size and the classification of the adjoining area.

8.19 Pressure stabilisers enable the room differential pressure to be set when the doors are shut, thus providing closed-door protection. When a door is opened, the stabilisers will close, forcing air to be directed through the doorway, thus providing open-door protection. Provided that the dilution criteria in Appendix 3 are met, the occasional small back-flows created (when two doors are opened simultaneously; or when there is a high temperature difference across an open door) will have little effect on the overall air cleanliness of the affected room.

8.20 In applications where it is critical to maintain a specific airflow and/or pressure regime, for example isolation rooms, all windows in the zone should be locked shut or sealed. Trickle vents, if fitted, should also be sealed.

8.21 The design of the ventilation system for an area depends on the overall configuration of the department. Where the department is served by more than one AHU the control of the units may need to be interlocked so that reverse airflow patterns do not occur.

8.22 Extract grilles should be sited and balanced to promote air movement in the desired direction.

8.23 Transfer grilles enable air to pass in either direction between rooms of equal class and pressure. Pressure stabilisers operate in one direction only; they allow excess air to be directed to the area desired and assist in maintaining room pressure differentials.

8.24 The relative locations of supply and extract terminals and their design air volume rates will determine the basic airflow between adjacent spaces. Transfer grilles and pressure stabilisers will permit and control the flow of air between spaces, ensuring a flow from the clean to less clean areas of the suite. Failure to provide such devices will lead to uncontrolled airflows when personnel move between rooms and doors being held partially open by air pressure.

Air handling unit

8.25 AHUs should be to the standard set out in Chapter 9. The extent of the system served by an individual AHU should reflect the operational need and required resilience of the application.

Fire aspects

8.26 When considering the overall airflow movement, careful thought needs to be given to the operation of the ventilation system to limit smoke spread in the event of a fire.

Operating department

General

8.27 An operating department will consist of one or more operating suites, a recovery area, sterile pack and equipment stores, entry/exit/service corridors, office, staff changing and support facilities. Each operating suite will typically comprise a preparation room, operating theatre, anaesthetic room, scrub area and a utility room. In order to ensure satisfactory conditions and the correct movement of air, the entire department will usually be mechanically ventilated.

8.28 The information given in this section relates to conventional operating suites used for general surgery. It will be applicable to other types of operating suite such as maternity whose layout and dimensions conform to the principles of Health Building Note 26 (see Note below). Additional information for UCV theatres is given in paragraphs 8.75 onwards.

Note:

Health Building Note 26 – 'Facilities for surgical procedures' (2004) and Health Building Note 10-02 – 'Facilities for day surgery units' (2007) are under revision and will be replaced by a single document: Health Building Note 10-01. It will provide guidance on the planning and design of infrastructure for in-patient and day-patient surgical services in the UK.

8.29 For other types of operating suite, the standard values may need to be adjusted to reflect non-standard room sizes, pressure regimes and air-change rates. A method of obtaining a design solution for non-standard theatres from first principles is given in Appendix 8 (see also paragraph 8.3 and accompanying Note).

Standard air movement control schemes

8.30 In all previous versions of this guidance, standard air-movement control schemes were given that provided a range of design solutions for typical operating-suite layouts. Improvements in the technology of ventilation control systems coupled with the ability to accurately sense and control real-time fan output has enabled operating-suite ventilation parameters to be tightened. These now more accurately meet the airborne-infection-control requirement (see the Lidwell Report). The previous standard design solutions have therefore been fully revised to take advantage of the technological advances and benefit from the reduced energy consumption and plant size they allow.

8.31 A new set of standard operating suite design solutions extensively amended to conform to the guidance contained in this edition of Health Technical Memorandum 03-01 are given in Appendix 7. They contain diagrams that show the relationship of rooms and the various doors and transfer devices between them but should not be regarded as architectural layouts. The schemes have been developed using the methodology described in Appendix 8.

These design solutions should be used for new projects and when refurbishing or upgrading existing operating suites.

8.32 Any other scheme may be used, and the standard solutions applied, if the following conditions are met:

- room relationships in air network terms are as shown in the plans;
- room sizes and shapes approximate to those given in Health Building Note 26 (under revision at the time of writing and to become Health Building Note 10-01);
- door gaps approximate to those given in the designer's notes in Appendix 4;
- casual heat gains are accounted for;
- a trimmer battery is installed in the air supply to the anaesthetic room;
- leakage through the structure is kept to a minimum. Note that theatre suites will be subject to an air permeability test at first-fix and final validation (see Chapters 10 and 12).

It is recommended that every effort should be made to adopt one of the schemes described above.

Ventilation design requirement

8.33 The need for ventilation of the individual rooms and areas within the operating department will be as follows:

- Preparation room – to protect sterile packs and instruments from pre-contamination.
- Operating theatre – to control the airborne infection risk, remove airborne contaminants and prevent the ingress of airborne contaminants from adjacent areas.
- Anaesthetic room – to protect staff from casual exposure to anaesthetic agents and maintain a suitable environment for patients.
- Scrub – to remove aerosolised microbiological contamination and moisture released when staff scrub-up.
- Utility (also known as sluice or disposal) – to contain any airborne hazards arising from the initial processing of biological material, contaminated instruments and general waste and prevent it entering the operating theatre or adjacent spaces.
- Entry/exit/service corridors – to remove vitiated air cascading from the operating suite(s).
- Sterile pack and equipment stores – to prevent airborne contamination of the packs and equipment.
- Staff changing, shower and toilet facilities – odour control and moisture removal.
- Staff rest room – moisture and odour control.
- Office and general areas – comfort conditions.
- Recovery – to protect staff from casual exposure to exhaled anaesthetic agents and maintain a suitable environment for patients.

The ventilation requirement for each space will be met by the desired air-change rate, room pressure differential, relative position of the room supply and extract, comfort requirement or a combination of all elements.

8.34 Preparation room – sterile pack store (SPS) – The preparation room is used simply as a store; sterile packs are set out on trolleys but not opened. They are then transferred to the operating theatre and opened as required. The nominal room

pressure can therefore be the same as that of the operating theatre and the air allowed flow between the rooms in either direction. Air supplied to the preparation room should be directed into the operating theatre either through a door-mounted transfer grille or if no door is fitted, through the opening. It should not flow via a pressure stabiliser or transfer grille into the corridor.

8.35 Preparation room "lay up" – When the preparation room is used as an instrument "lay up" room (that is, sterile packs are opened and their contents exposed ready for transfer to the operating theatre), it should be regarded as being of greater cleanliness than the operating theatre. The preparation room should be at 10 Pa above the operating theatre to minimise the transfer of air and prevent pre-contamination of the instruments. The design air supply volume should relate to the door protection factors (for example, open door to theatre and closed door or hatch to corridor, where provided) and result in not less than 22 ac/h. Air should discharge into the operating theatre through a pressure stabiliser fitted with a stand-off baffle plate on the theatre side (see photograph). It should not flow via a pressure stabiliser or transfer grille into the corridor. The volume of supply air being discharged through the pressure stabiliser may be used to offset the volume of supply air to the operating theatre.

Pressure stabiliser fitted with stand-off baffle in preparation "lay up" room

Note:

It is undesirable to share a "lay up" preparation room between two theatres as it complicates the air movement scheme and in practice becomes a shortcut for staff. If door interlocks are provided, staff often disable them.

If space does not allow the provision of individual lay-up preparation rooms, a central lay-up preparation room with instrument transfer to individual theatres in closed trolleys should be considered.

8.36 Operating theatre – The supply of air to an operating theatre has four main functions:

a. to dilute airborne microbial contamination – this will arise from the surgical activity and microbiological material shed by staff;

b. to aid the removal of and dilute fumes, odours and waste anaesthetic agents;

c. to control air movement so that the airborne contaminants from other less clean areas do not enter;

d. to control the temperature and if necessary, the humidity of the room.

Design notes

- An air-change rate of 22 ac/h will control (a) and (b) above. When calculating the air volume required to achieve the air-change rate, the physical volume of the operating theatre will be based on whether the scrub does or does not form part of it. See Note to paragraph 8.46 for further information.

- The room to corridor differential pressure and amount of air required to give door protection will control (c). Door protection is calculated on the basis that during use, only one door or a single leaf of a double door will be open transiently, and all the rest will be closed. The designated "open" door will be the worst case (for example, typically that between the operating theatre and utility). The volume of supply air can be calculated from the flow rates for open and closed door protection given in Appendices 4 and 5. The smaller the number of rooms (and therefore doorways) leading from the operating theatre the better, as traffic is reduced, and a less complicated air movement control scheme is required.
- The supply air volume to control (d) temperature and humidity conditions can be calculated conventionally, taking account of all heat and moisture gains and losses resulting from equipment, lighting and number of occupants. Supply to room air temperature differences of up to 10 K for winter heating and 7 K for summer cooling should not be exceeded. Room humidity should not exceed 70% saturation.

The design supply air volume for an operating theatre will be whichever of the above calculations yields the greater figure.

In the case of an operating suite with a "lay up" preparation room, the actual air volume supplied by the operating theatre terminals will be the design air volume determined above minus that entering via the preparation room pressure stabiliser.

Note:

In the majority of operating theatres the air-change rate will be the dominant factor; however for small operating theatres the door protection factor may dominate.

8.37 The supply and extract terminals should be positioned to ensure that all parts of the operating theatre are actively ventilated. The ceiling should be divided into four quadrants and a supply terminal positioned at the centre of each quadrant and along the lines that join them as necessary to ensure that all parts of the room are equally supplied. In a large theatre, additional terminals around the centre point may be necessary to promote efficient scouring and achieve satisfactory air movement at the operating table level. This will help create in ventilation terms a well-mixed space and ensure good dilution of any airborne contaminants. Extract and air-out paths via door gaps, transfer grilles, pressure stabilisers and low-level active extract should be evenly distributed to encourage efficient scouring of the room. A minimum of three and preferably four air-out paths, approximately equally spaced, should be provided.

Note:

In order to ensure correct air distribution, it is essential that the supply terminal locations are not displaced by light fittings or ceiling-mounted pendants and articulated booms. Ideally the supply terminals should alternate with light fittings along the quadrant lines described above.

8.38 Supply terminals should be ceiling-mounted circular "air master" style, square "four-way blow" or perforated plate style that produce a downward displacement, turbulent airflow (see paragraph 9.170 onwards). Multi-section plenum-style perforated-flow diffusers with a footprint that encompasses the operating site are acceptable but may be prone to buoyancy effects as a result of temperature difference. Manufacturers' type test data

should be consulted to ensure that the terminal will achieve the required performance envelope. Note that these are not true laminar flow systems in the strict sense of the word but produce a downward displacement parallel flow style of air distribution.

Note:

Where an operating theatre requires a higher than normal air-change rate (for example, cranial surgery, which may specify 35 ac/h), the volume of supply air means that four-way blow diffusers would be noisy and probably cause unacceptable draughts. A UCV terminal would deliver too much air, which could result in exposed tissue drying out during the procedure. A multi-section, plenum-style perforated flow diffuser with a footprint that encompasses the operating site would be the most suitable option.

8.39 The diffuser equipment chosen should not cause "dumping" and provide an air velocity 1 m above floor level at the operating position of between 0.2 m/s and 0.3 m/s.

8.40 Horizontal flow distribution should not be used in new installations; however, space constraints may force its retention when refurbishing existing installations. Where fitted, the supply grilles will require a means of directional adjustment that is lockable in position to prevent casual alteration in future when being cleaned.

8.41 Anaesthetic room – Anaesthetic gas or anaesthetic agents will be delivered to the respiratory tract of a patient either directly or using a carrier gas. Anaesthetic gases and agents are subject to workplace exposure limits and while beneficial to the patient are harmful to staff. Some leakage from the anaesthetic equipment and the patient's breathing circuit will occur with all systems, particularly during connection and disconnection, and from the interface with the patient. The room ventilation scheme should ensure that any leakage is diluted and removed, and that staff are in a clean airflow path. Locating the supply terminal on the ceiling in a position behind where the anaesthetist will normally stand, and the extract terminal at low level adjacent to the medical gas pipeline terminals, will encourage a clean airflow path past the breathing zone of the anaesthetist, thus reducing their casual exposure to airborne anaesthetic agents. (See information in Appendix 9.)

8.42 An operating theatre suite anaesthetic room that is equipped with a N_2O terminal or in which an anaesthetic agent is delivered to the respiratory tract of a patient using a carrier gas should have a design primary supply and extract flow rate to achieve 15 ac/h.

8.43 In order to maintain the core temperature of patients being anaesthetised, a trimmer heater-battery should be provided in the anaesthetic room supply. It is also important that the location of pressure stabilisers and transfer grilles does not cause draughts across the patient.

8.44 The anaesthetic room will be at an intermediate pressure between the operating theatre and corridor.

8.45 Scrub – This may be a separate room or a bay within the operating theatre. If the scrub is a separate room, a door between the scrub and operating theatre is an inconvenience to scrubbed staff and may be replaced by an opening that is larger than a normal single doorway. If a door is fitted between the scrub and operating theatre is should have a transfer grille in its lower half. In either case there should be an active extract at low level under the end of the scrub trough most remote from the operating theatre, or a low-level pressure stabiliser that discharges onto a corridor at the end of the scrub room most remote

from the operating theatre (see photograph). If the scrub has an outside wall and/or is particularly large, additional extract terminals may be required to ensure air movement throughout the entire space and prevent surface condensation and mould growth.

Scrub room with extract under trough

8.46 Where the scrub is a trough on the wall or in an open bay within the operating theatre, it should have low-level extract under it.

Note:

If the Scrub is in effect a separate room that is open (no door) to the operating theatre and it has a low-level pressure stabiliser discharging onto a corridor or an active low-level extract at its far end, so that air has to travel through the scrub to leave the operating theatre, the volume of the scrub will not be counted as being a part of the operating theatre room volume.

If the scrub is a trough on the wall or in an open bay within the operating theatre, the volume of space it occupies will be considered part of the operating theatre room volume for the purpose of calculating the operating theatre air supply.

8.47 Utility (sluice or disposal) – The room is kept at negative pressure with respect to the operating theatre so that contaminants contained in the surgical waste do not re-enter the operating theatre. A utility opening onto a clean corridor is considered to pose a greater risk than one opening onto a service corridor and so has a greater differential pressure. A utility may be shared between two operating theatres or be centralised to serve a group of operating suites.

8.48 Entry/exit corridor – Air cascading from the operating suite should be removed in the adjacent corridors. Note that though design flows may be calculated, the actual extract airflows may need to be adjusted at commissioning in order to achieve the design room differential pressures.

8.49 Service corridor – If materials to be disposed of are placed in impervious material for transportation, it is not necessary to have a separate corridor for this purpose. However, a service corridor has many operational advantages in terms of the flow of materials through the operating suite. It provides a heated envelope around the operating suite, thus obviating the need to run the theatre ventilation out of hours to maintain its temperature above dew-point, so significantly reducing energy consumption. Lastly it permits access for routine service and maintenance, and the eventual refurbishment of an operating suite without compromising the use of adjacent suites.

8.50 Sterile pack store – The central operating department sterile pack and prosthesis store should be supplied with 6 ac/h and be at a positive pressure to their corridor. It is important to coordinate the position of the supply air terminals with any racking so that the terminals are accessible for annual airflow measurement with a balometer.

8.51 Equipment store(s) – Supply air ventilation only to keep them at positive pressure to the corridor.

8.52 Staff changing, shower and toilet facilities – ventilation as per building regulations and for moisture control.

8.53 Staff rest room – Ventilation for kitchen area and general comfort.

8.54 Office and general areas – Ventilation as per building regulations and comfort.

8.55 Recovery room – Anaesthetic agents will be exhaled by patients while recovering; they are subject to workplace exposure limits and are harmful to staff. Anaesthetic gas scavenging systems (AGSS) will be provided but the room ventilation scheme should ensure that any leakage is diluted and removed.

8.56 The supply air terminals should be ceiling-mounted above the foot end of the recovery bed positions. Extract should be at low (bed height or below) level behind the bedhead positions or in the corners of the bed bay. This will establish a clean airflow path so that staff do not inhale anaesthetic agents exhaled by recovering patients (see the COSHH Regulations).

8.57 In an operating department recovery room, the design primary air supply will be 15 ac/h with a balanced airflow.

General notes

8.58 Supply flow rates for the main rooms of the operating suite are given in Appendix 7. For the other areas where room sizes and activities vary from site to site, air-change rates are given in Appendix 2 and Tables 2–7 in this chapter. These figures have been found to give enough dilution of airborne microbial contaminants, provided the mixing of room air is reasonably uniform.

8.59 For conventionally ventilated operating theatres, the primary air supply would be filtered in the AHU. Terminal filters, EPA or HEPA, are not required.

8.60 Air extracted from operating suites should not be recirculated as it may contain malodorous contaminants.

Note:

Where thermal wheels are used for energy recovery, the small leakage across them from extract to supply should not cause odour problems and is not considered aerobiologically significant. In any event, all the air supplied will pass through the final filter.

Operating suite pressure regime

8.61 When designing the ventilation scheme the room pressure differentials given in Appendix 7 should be used. However, when the suite is balanced and commissioned these values are not to be taken as immutable but rather as desired orders of magnitude. What is important is the direction of airflow between rooms when doors are closed. Specifying doors of a laboratory standard that close and sit against a seal or have drop seals on their bottom edge is not necessary and will be counterproductive of the aim to allow air to flow from clean to less clean areas.

Note:

Fire officers often require that doors are fitted with cold smoke seals as standard. These will significantly reduce the door-leakage rate and increase the differential pressure when new and undamaged. It is therefore recommended that provision for the design door leakage be factored into the sizing of the appropriate transfer grille or pressure stabiliser.

Temperature and humidity control and indication

8.62 In an operating theatre the temperature should be adjustable within the range 18°C to 25°C by the staff at the

theatre control panel. The ventilation system should be capable of maintaining an internal temperature of 20°C at summer outside design and 22°C at winter outside design in all but the most extreme outside conditions. There may be instances where these temperatures may not be appropriate (for example, children and patients with a low body mass). The internal design temperatures should then be discussed with the VSG and agreed in writing.

8.63 Theatre temperature and humidity control sensors should be actively ventilated. They would typically be located in a sampling extract duct mounted in or adjacent to the theatre control panel, positioned at normal working height (1.5 m above finished floor level). Alternatively, they may be mounted in one of the operating theatre's low-level extract ducts. Whichever location is chosen they should be accessible for cleaning, and removable for periodic calibration and replacement.

8.64 Passive wall-mounted temperature and humidity sensors are not recommended.

8.65 Controls should be provided to enable operating department ventilation plant to be closed down when the operating suites are unoccupied (see also Chapter 9).

8.66 When in the "off" mode, to provide dewpoint protection the control system should switch the ventilation "on" to "Set back" if the space temperature falls below 16°C.

8.67 All operating theatres and rooms where surgical interventions are carried out should have a control panel mounted on a wall with its screen centre at 1.5 m high and in the direct line of sight of staff standing at the normal operating position. The theatre control panel should include plant status indication, clearly readable temperature and humidity indicating gauges, and a means of adjusting the set point for temperature. Theatre ventilation plant status indication should also be located at the operating department staff control base (see the Specialised Ventilation for Healthcare Society's (2017) SVHSoc.01 – 'Operating theatres: energy control strategies and the surgeon's panel' for further details).

8.68 The following indicators should be incorporated in the theatre control panel and their functions clearly labelled.

- A readout sufficiently large (25 mm) to be clearly visible from the operating table that shows the temperature of the air in the theatre.
- A readout sufficiently large (25 mm) to be clearly visible from the operating table that shows the relative humidity of the air in the theatre.
- A red indicator light that will illuminate when either the supply AHU fails or is switched off or is in "Set back" (legend: "Theatre not to be used in this condition").
- A green indicator light that will illuminate when the supply AHU is operating at full speed (legend: "Conventional theatre mode").

Note:

In touch-screen panels, the red indicator should be a band across the screen with the statement "**Theatre ventilation not operational. Do not use**". The green indicator may be moving arrows representing airflow with the legend "**Ventilation operational**".

8.69 The humidity within the operating department when in use should fall within the range 35% to 60%. Where it is considered necessary to fit a humidifier, it should be selected to humidify to 40% saturation at 22°C during the design winter outside conditions. The cooling coil should be able to remove sufficient moisture so

that 60% saturation at 20°C is not exceeded during the design summer outside conditions.

Note:

When not in use the humidity may be allowed to fall below 35% but should not be allowed to rise above 70%.

8.70 The automatic control of ventilation in operating suites needs to be simple and robust. Over-reliance on complex room pressure and flow relationships linked to automatic fan speed control are unnecessary and in the long term have been shown to be unreliable. Complex software algorithms that can only be accessed and interpreted by off-site specialists should not be used. Whichever control strategy is chosen, it is important that on-site staff have the facility to override the control system and keep the ventilation operating at least until the surgical procedure is complete (see also Chapter 9).

Operating suite air handling unit

8.71 Each conventional operating theatre suite should have its own dedicated AHU to the standard set out in Chapter 9. To ensure operational flexibility and permit routine maintenance, an air handling unit should not be shared between suites.

8.72 In retrofit installations, site conditions may preclude individual AHUs for each suite. In these circumstances, subject to VSG approval, an AHU may be shared between not more than two operating suites providing each suite has its own control of temperature. An accessible airflow measurement test point should be provided in the supply branch duct to each theatre suite so that the primary air volume to each can be determined. In addition, the branch supply and extract should be capable of being physically isolated and the main airflow rate reduced so that either suite can be taken out of use without detriment to operating conditions in the other.

Note:

An AHU provided under paragraph 8.72 may be shared between two conventional operating suites, but not between a conventional and a UCV suite.

8.73 The AHU supply and extract fans should be interlocked so that the supply starts up first and shuts down last, thus preventing reverse airflows. If the extract plant fails when the theatre is in use, it may continue to be used but a warning should show on the BMS and theatre control panel. If the supply fails when the theatre is in use the extract should shut down to prevent reverse airflows and an alarm should sound and show on the theatre control panel.

Fire aspects

8.74 When considering the overall airflow movement, careful thought needs to be given to the operation of the ventilation system to limit smoke spread in the event of a fire. However, this is a highly staffed department with a low fire risk/load status and these factors need to be recognised when developing the fire strategy. Operating departments typically comprise a series of linked rooms with multiple exits. Over-compartmentation can lead to difficulties in establishing clean airflow paths and room air dilution rates. This will lead to an increased risk of healthcare-acquired infections. Staff areas within the department should be treated as a subcompartment.

Ultra-clean ventilation system

General requirements

8.75 The design philosophy of a conventionally ventilated operating suite is based on the need to dilute contaminants

and control both the condition and movement of air in an operating suite. Ultra-clean ventilation (UCV) is a means of significantly increasing the dilution effect by providing a large volume of clean filtered air to the zone in which an operation is performed, and sterile items are exposed. Air is discharged above the operating zone and while not truly laminar, its downward displacement purges the clean zone of contaminants and particles generated by the activities within it. The airflow in and around the clean zone also serves to prevent particles originating outside the zone from entering it. The resulting reduction in contaminants has been shown to significantly reduce post-operative sepsis following certain orthopaedic procedures.

Note:

The number of microorganisms that are present in the air at the wound site and exposed surgical items is dependent on the operating team, their procedural discipline, choice of clothing and the type of UCV system. Ultra-clean air is defined as that containing not more than 10 colony forming units per cubic metre of air (10 cfu/m^3) present at the wound site during a surgical procedure. In practice levels of only 1 cfu/m^3 are often attained.

8.76 UCV systems are very successful in reducing contaminants at the wound site so it is often considered that there is no need for complex air movement control schemes in the rest of the suite. However, when designing the ventilation scheme, it should be noted that the users may switch the UCV terminal to "low speed" when non-orthopaedic surgery is taking place. This is because the high airflow rates can cause increased moisture evaporation of exposed tissue which may be detrimental to the surgical outcome. In recognition of this, the ventilation scheme should be capable of providing operating conditions to at least a "conventional" theatre standard throughout the suite with the UCV in "low speed" mode. It should also be remembered that suitable levels of ventilation will always be required in the peripheral rooms.

8.77 UCV systems can be designed and built from first principles or a range of bespoke modular units of varying shapes and sizes are available, with each manufacturer having a slightly different approach to UCV design. Notwithstanding any variation in their design philosophy, all UCV systems will be required to completely achieve the performance standard set out in Chapter 12.

8.78 As with conventional theatres, each UCV operating suite should have its own dedicated AHU to the standard set out in Chapter 9. To ensure operational flexibility and permit routine maintenance, an AHU should not be shared between suites.

8.79 In retrofit installations, site conditions may preclude individual AHUs for each suite. In these circumstances, subject to VSG approval, an AHU may be shared between not more than two UCV operating suites providing each suite has its own control of temperature. An accessible airflow measurement test point should be provided in the supply branch duct to each theatre so that the primary air volume to each UCV canopy can be determined. In addition, the branch supply and extract should be capable of being physically isolated and the main airflow rate reduced so that either suite can be taken out of use without detriment to operating conditions in the other.

Note:

An AHU provided under paragraph 8.79 may be shared between two UCV operating suites, but not between a conventional and a UCV suite.

8.80 An inherent feature of a UCV system is its large airflow so it is essential to recirculate the air supplied to the operating theatre and/or to recover its energy in order to optimise operating costs.

8.81 The primary fresh air volume supplied to a UCV operating suite will be the same as for a conventional suite and it should be dispersed to the rooms in the suite in the same manner. The UCV canopy will typically incorporate recirculation fans. In order to prevent these fans "robbing" the air supply to the rooms, the primary air supply to the UCV theatre suite should be split into two ducts each with a volume control damper – one duct to feed the UCV canopy and the other for the anaesthetic and preparation rooms.

8.82 "Laying up" instruments in the clean zone is preferable microbiologically and considered best practice by the Royal College of Orthopaedic Surgeons, so an SPS preparation room should be provided. A transfer grille will be needed in the door between the theatre and preparation room.

8.83 If the client requires a "lay up" preparation room, a pressure stabiliser will be required between the preparation room and theatre. It should be fitted with a baffle on the theatre side to prevent air transfer interfering with the airflow distribution under the UCV canopy.

8.84 Separate scrub-up or disposal facilities are not necessary for air cleanliness, although operational policy may prefer such a provision. A separate anaesthetic room should however be provided.

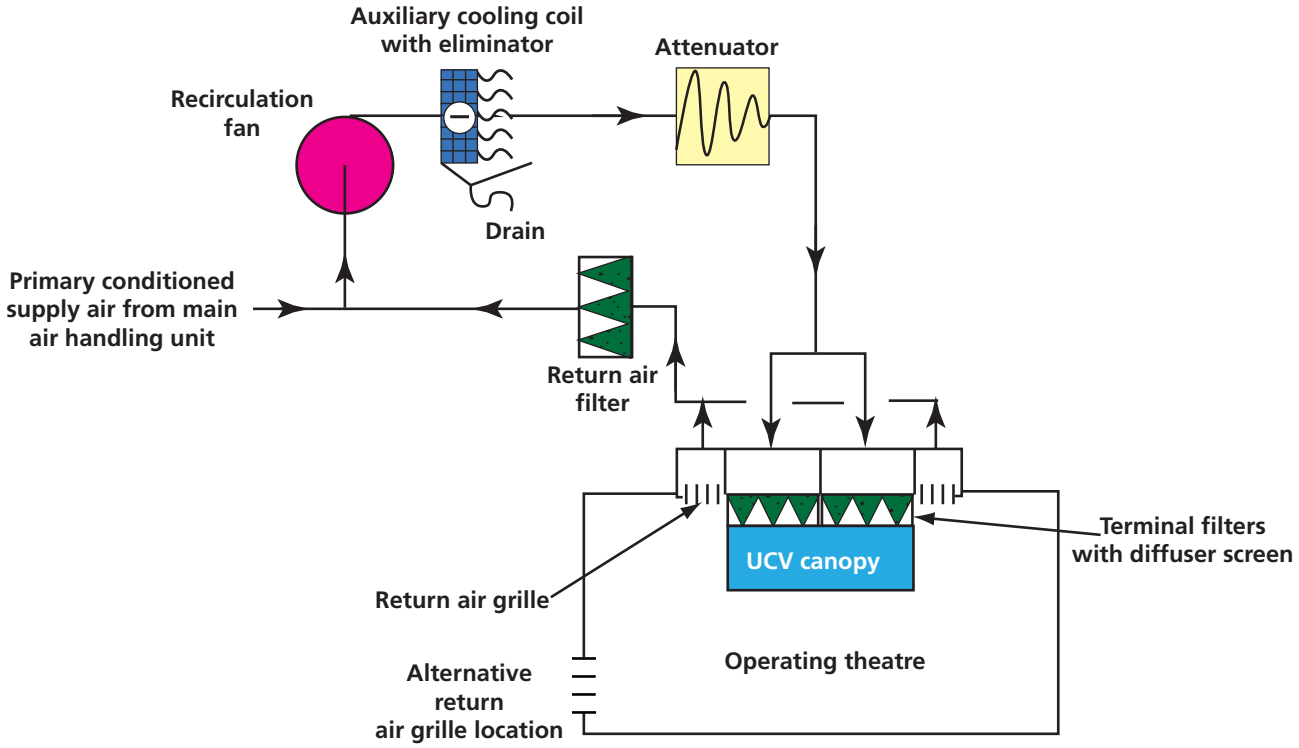
Types of UCV system

Remote plant systems

8.85 In a remote plant system, all the air-conditioning equipment is located outside of the operating theatre, except for the unidirectional airflow terminal, terminal filter, air diffuser and the return air grilles (see Figure 1).

8.86 This arrangement has the following advantages:

Figure 1 UCV remote plant system



- The recirculation fans are out of the theatre, thus reducing noise. Multiple recirculation fans may be replaced by a single fan unit.
- Casual heat gains from recirculation fan(s), canopy lights, equipment and people within the theatre can be removed by a cooling coil in the return air stream. This will prevent heat build-up in the theatre.
- The return air filters can be changed without needing access to the theatre, making routine maintenance more feasible.
- The opportunity exists to locate the EPA filter in the primary supply duct rather than the theatre terminal. This will reduce the number of filters required and allow them to be changed without entering the theatre.

Modular systems

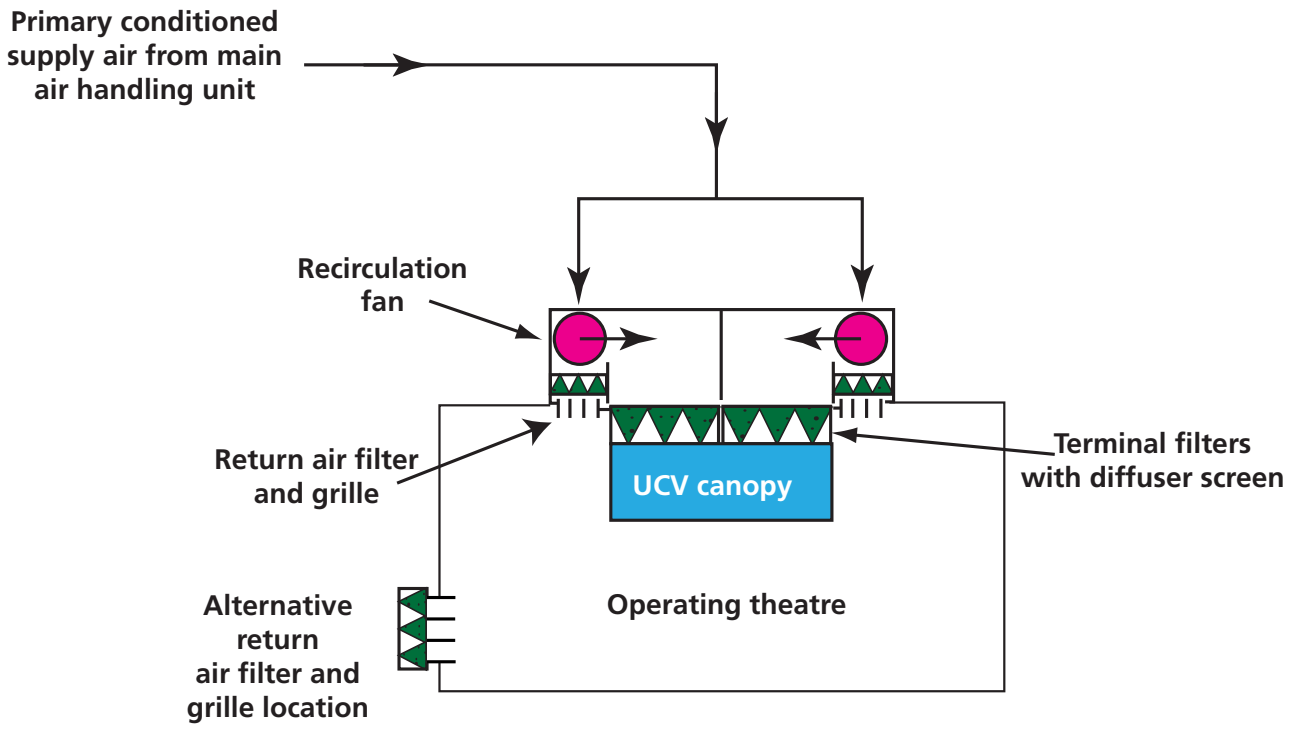
8.87 Vertical-flow modular units comprise a ceiling-mounted canopy containing return air filters, final filter and air diffuser. Primary air is supplied by a remote air-conditioning unit at the volume and to the standard required for a conventional operating suite. The UCV-canopy return-air fans may be within the unit or mounted independently of it in the ceiling void or wall space (see Figure 2).

8.88 Modular units have the following advantages:

- As they are produced in a modular form, installation is generally more straightforward.
- They can be used to upgrade an existing conventional operating suite to a UCV suite without the need to change the AHU.
- All the UCV elements are in one place, making maintenance simpler.

8.89 UCV systems can be designed and built from first principles, or a range of bespoke modular units of varying shapes and sizes are available, with each manufacturer

Figure 2 UCV modular system



having a slightly different approach to UCV design. Whichever system is used, in order for the UCV terminal to produce the desired airflow within its footprint without entraining non-filtered air, the physical outside edge of the UCV canopy unit should not be less than 1 m from the operating theatre wall.

Notwithstanding any variation in their design philosophy, all UCV systems will be required to completely achieve the performance standard set out in Chapter 12.

Vertical flow UCV systems

8.90 Vertical flow systems are effective at reducing infection risks (Lidwell et al., 1982). Some systems have no walls and use auxiliary fans to create an air curtain around the clean zone. Partial wall systems have side screens that terminate 2 m above floor level and full wall UCV have side screens that terminate 1 m above floor level.

8.91 Full wall systems provide a physical barrier between the operating team and other theatre occupants and guide the air down to the operating table level. They can therefore work at a lower air velocity.

8.92 Siting the return air grilles around the periphery of the theatre at low level will help control short-circuiting and give an improved airflow path. In any event there should be an "air out" path on each face or in each corner of the theatre. These may be provided by combination of pressure stabilisers and passive or active low-level extract grilles. Failure to provide "air out" paths on all faces of the theatre may result in the surplus air causing entrainment into the clean zone.

8.93 Vertical systems should have a clean zone large enough to encompass the operating site and all instrument trays likely to be needed for the procedures to be undertaken. Where the surgical site is small, a 1.4 m circular or rectangular terminal may be provided. For major orthopaedic procedures, a minimum size of 2.8 m × 2.8 m will be required. This is the area projected on the floor under the supply air terminal within the full walls, partial walls or air curtain. Any air outside this zone cannot be guaranteed to be ultra-clean although given the dilution factor, the level of microbiological contamination will be much lower than the general level in a conventional operating theatre. Having a contrasting coloured area on the floor delineating the extent of the "clean zone" will assist staff and is therefore essential.

Note:

The entire "clean zone" footprint of the UCV canopy will be designated by a contrasting coloured inlay in the floor covering. A line marked on, or cut into, the floor covering is not sufficient and will not be accepted at validation.

8.94 When upgrading an existing conventional theatre to an ultra-clean standard the only solution may be the installation of a modular system. In these units, the heat gains from the return air fans may warrant the inclusion of supplementary cooling within the module. However, issues of cooling-coil drainage, condensate removal and maintenance access within the space constraints of the module may make this option impracticable. The additional cooling load should then be catered for by conditioning the primary air to compensate.

8.95 If an existing AHU is to be retained, it may require modification to ensure that it achieves the standards set out in Chapter 9 of this document (see also paragraph 4.73). The fan may need re-rating to accommodate the change in system resistance. The cooling coil may also need to be upgraded to cater for the increased load resulting from the return air fans and terminal lights. Failure to make adequate

provision for this may make the theatre unusable during prolonged warm spells.

8.96 A factor affecting the airflow pattern is the supply/room air temperature difference. When the supply air temperature is significantly above room temperature, buoyancy effects will reduce the volume of air reaching the operating zone. This can occur at start-up in a large theatre where the temperature when not in use has dropped below 18°C. If it is anticipated at design stage that this will be a regular occurrence, a system incorporating full walls should be used. Demountable extensions that convert a partial wall to a full wall unit are available.

8.97 Convection up-currents from the surgical team and operating lamp tend to counter the movement of clean air towards the operating site, hence the air velocity reaching the operating level is critical. The minimum velocity given below has been selected to take account of these factors and is greater than the theoretical minimum value. For all vertical UCV systems the design discharge velocities will be as follows:

- Air velocity 2 m above floor level:
  - no side wall system = 0.38 m/s average;
  - partial wall system = 0.38 m/s average;
  - full wall system = 0.30 m/s average.
- Air velocity 1 m above floor level:
  - all systems = 0.2 m/s minimum within the inner operating zone.

Chapter 12 gives details of the method of measurement.

8.98 Variable speed recirculation fans with differential pressure control may be the most suitable solution for maintaining consistent performance and energy saving. The recirculation fans should be accessible for replacement without the need to disturb the fabric of the operating suite.

UCV filters

8.99 The AHU primary and secondary filters should be to the standards and in the location set out in Chapter 9.

8.100 Terminal filters should be provided within the UCV canopy or in the air supply to it. Efficiency particulate air (EPA) filters grade E10 as specified in BS EN 1822 will be required as a minimum. There is no aerobiological benefit in fitting filters of a higher grade than this.

8.101 In some modular UCV units their manufacturers state that the terminal filter is used as a pressure equaliser to balance airflow so a grade higher than E10 is fitted. The increased resistance may affect the velocity of air reaching the operating level and there will be penalties in terms of installed fan power, energy consumption and higher noise levels.

8.102 The final filters should be installed in a leak-proof housing in a manner which allows the terminal unit, filters and their seals to be validated. The UCV canopy and its terminal filters will be scanned with a light scattering airborne particle counter (LSAPC) during validation to prove the effectiveness of the complete installation.

8.103 Where UCV units are constructed in sections, a means of measuring the pressure drop across the terminal filters in each section should be provided. The pressure test points should be located outside of the partial wall, capped to prevent air leakage and accessible within the theatre without the need to open the unit inspection panels. Alternatively, direct-reading non-electronic pressure gauges (of the minihelic type) may be fitted.

8.104 The UCV system will require a return air filter to capture the relatively coarse particles which would otherwise

significantly reduce the life of the final filter. This should be at least an ISO 16890 Coarse 60%. In remote recirculation systems there may be advantages in fitting a higher-grade return air filter as it will reduce the load on the terminal EPA filters and extend their life.

Noise level

8.105 If sound-attenuating material is used to line any portion of the inside of the UCV unit it should be non-particle shedding and non-combustible.

8.106 The maximum noise level in an operating theatre fitted with a UCV terminal of any type should not exceed 53 dB(A). Chapter 12 gives details of the method of measurement.

Lighting and operating lights

8.107 The position of the UCV light fittings and style of partial walls, where fitted, should neither adversely disturb the airflow nor result in significant spatial variations in illuminance levels.

8.108 In vertical units, specialised task lighting should be provided by toroidal, cruciform or small multiple dome-shaped luminaires as they have good aerodynamic properties. The ideal luminaire will have a minimal effect on the airflow regardless of where it is positioned. Large diameter saucer-shaped luminaires should not be used in vertical flow systems as they will occlude the airflow in the critical central zone. It is important to consider the suitability of existing luminaires when retrofitting UCV systems.

8.109 In vertical UCV installations the distance between the UCV canopy diffuser screen and the floor should be between 2.75 m and 3 m. This will allow space for the operating lamps and their articulation arms, and ensure that air at the correct velocity arrives at the operating level. When parked, the lowest point of the central light stem, luminaire, monitor, camera, their associated articulation arms and any other ceiling-hung equipment should never be less than 2 m above floor level.

Note:

The traditional means of light support is a central column that passes through the UCV canopy and is rigidly fixed to the building structure. The position of the support therefore prevents air being supplied at the centre of the canopy. Separate supports displaced from the centre of the clean zone would lead to improved airflow. This approach was advocated in the 1994 version of this guidance but at the time of writing no UK manufacturer has chosen to adopt this solution. Alternatively, equipping the operating team with battery-powered headset lamps may remove the need for traditional operating lamps and their supports.

Controls and instrumentation

8.110 The functions of the supply AHU and extract ventilation should be continuously monitored by a BMS control unit and interlocked with the UCV terminal control and monitoring functions. The room temperature sensor should be located in the re-circulated air return path. The controls and instrumentation for the main plant are set out in Chapter 9.

8.111 UCV systems will additionally require a low speed facility that can reduce the air supplied through the UCV canopy to a volume that equates to not less than 22 ac/h of the operating theatre gross volume or that required for door protection, whichever is greater, whilst still leaving the supply AHU operating at full speed. In this operational mode the theatre may be used as a conventional operating suite. A means of switching between

conventional and UCV mode will be provided on the theatre control panel and its function clearly labelled (see the Specialised Ventilation for Healthcare Society's (2017) SVHSoc.01 – 'Operating theatres: energy control strategies and the surgeon's panel' for further details).

Note:

UCV theatre ventilation may be completely switched off when the theatre is not in use, but the room temperature should not be allowed to drop below 18°C (see paragraph 8.96). The AHU and UCV control should be interlocked so that when the AHU goes to "Set back" the UCV also goes to "Set back", and if the AHU goes "Off", the UCV terminal fans also switch "Off". There is no aerobiological benefit in keeping the UCV terminal fans running when the theatre is not in use, it results in wasted energy.

8.112 The following indicators should be incorporated in the theatre control panel and their functions clearly labelled. In retrofit installations an auxiliary panel for the UCV may be the most practical option. If fitted it should be mounted adjacent to the theatre panel and their control functions interlocked.

- A readout sufficiently large (25 mm) to be clearly visible from the operating table that shows the temperature of the air at the UCV canopy.
- A readout sufficiently large (25 mm) to be clearly visible from the operating table that shows the relative humidity of the air at the UCV canopy.
- A red indicator light that will illuminate when either the supply AHU or the UCV canopy fails, or either or both are switched off or the AHU is in "Set back" (legend: "Theatre not to be used in this condition").
- An amber indicator light that will illuminate when the UCV canopy is at low speed and the supply AHU is running at full speed (legend: "Conventional theatre mode").
- A green indicator light that will illuminate when both the supply AHU and UCV canopy are operating at full speed (legend: "UCV theatre mode").
- A blue indicator light that will illuminate when the UCV canopy airflow, as detected by a differential pressure sensor, falls below 80% of the design flow rate (legend: "UCV requires service").

Note:

In touch screen panels the red indicator should be a band across the screen with the statement "**Theatre ventilation not operational. Do not use**" The amber indicator may be moving arrows representing airflow with the legend "**Conventional Theatre mode**". The green indicator may be moving arrows representing airflow with the legend "**UCV Theatre mode**". The blue indicator may be a band across the UCV terminal mimic stating "**UCV requires servicing**".

8.113 When a system is designed to have partial walls with full wall extensions, a volume control facility may be incorporated to allow the system to be run with reduced velocity when the demountable full walls are in place. It would be the responsibility of the user to ensure correct operation of the system. To assist the user, an explanatory notice should be included on the theatre control panel.

8.114 The UCV unit manufacturer's control box should be located in an accessible position preferably in the operating department adjacent to the operating

theatre that it serves. A service corridor, if provided, is an ideal location. The control box should be clearly labelled with the identity of the operating theatre that it serves.

Barn and semi-barn theatres

8.115 There is no aerobiological reason why two or more UCV systems should not be installed in a common area if adequate spacing is provided. These are known as barn theatres and require special design considerations and operational discipline. The relative positions of the UCV units, temperature control range and location of doors and openings to other areas will all significantly affect the airflow at the operating positions.

8.116 A barn theatre has two or more operating positions each ventilated by a UCV canopy all in one open operating theatre. There may be a common scrub trough, SPS preparation room and shared utility, all of which reduce the facility's footprint. For reasons of privacy and dignity, there is usually a separate anaesthetic room for each operating position. The operating positions may be separated by glass screens to prevent bone fragments being propelled from one position to another when high-pressure air-driven surgical tools are being used.

8.117 A semi-barn theatre is very similar but would have a full-height dividing wall between the operating positions. The wall will not extend across the full width of the room, only its middle section. This creates a degree of physical separation between the operating positions but allows staff to walk from one to another around the ends of the dividing wall.

8.118 It is important that the physical layout and ventilation strategy of the barn or semi-barn are in harmony if the installation is to work successfully. The following points should be resolved with the architect and VSG when considering the design:

- In order to reduce the risk of pre-contamination, surgical instruments should not have to pass one operating position in order to get to the one that they are destined for.
- Staff having scrubbed should not have to pass one operating position in order to get to the one that they are destined for.
- Waste material being cleared from an operating position should not pass another when being removed from the operating theatre.
- The operating positions and their UCV canopies should be placed in line and not staggered or offset, otherwise their airflow patterns will interfere with each other.
- While barns and semi-barns have, from the staffing and space utilisation point of view, many advantages, they can create problems with temperature control and energy efficiency. It is not advisable to shut their ventilation off at night or weekends as if the operating theatre temperature drops it can take a considerable time for the ventilation to achieve the required air velocity at the operating position (paragraph 8.96). Because the barn is a large open space, when it becomes cold the warm air supplied by the UCV canopies tends to rise and stratification occurs. As a result, although from the user's point of view the ventilation appears to be running, the air being delivered does not actually have enough velocity to reach the operating table.
- Access for service, maintenance and future upgrades or refurbishment will be restricted as this can only be carried out when none of the operating positions is in use.

8.119 Ventilation of each UCV canopy and associated anaesthetic room will be by a dedicated AHU; ventilation of the shared spaces and perhaps recovery area would either be shared between the operating position AHUs or provided by a separate AHU.

Hybrid theatres

8.120 A designation given to operating theatres that contain scanning equipment on a robotic arm. Major surgical procedures are carried out and the patient is scanned as necessary during the procedure. The scanning equipment may be floor-mounted or ceiling-hung and there will be one or more large monitors, a variety of screens and the medical gas terminal units all ceiling-hung on articulated pendants. The number of pendants and their supporting steelwork can reduce the space available to install ventilation ductwork and compromise the location of the supply air terminals. Liaison with the architects at an early stage in the project design is essential to ensure a satisfactory ventilation solution.

8.121 Hybrid theatres tend to be significantly larger than conventional theatres and may have a radiation protected control room and an equipment room to house the servers for the scanning equipment and its robotic arm in addition to the standard operating suite of rooms. The ventilation load will therefore be larger and standard solutions should be adapted to suit or the designer will need to return to first principles (see Appendix 8).

8.122 Because of the increased airflow requirement, the AHU will be larger than for a standard conventional operating suite.

8.123 In all other respects the ventilation design and theatre control panel will be as for a conventional operating suite as above.

Neutral pressure theatres for infectious patients

8.124 The client may have a requirement for an operating suite for surgery on infectious patients. This may be a dedicated neutral-pressure operating suite or a standard operating suite that is designed to be easily convertible to a neutral-pressure suite. If airborne microorganisms liberated from a patient during a surgical procedure are allowed to cascade out into the adjacent corridors, they could infect other patients or the staff in the operating department.

8.125 The room provision and layout will be as for a conventional operating suite with the following variation to the ventilation scheme:

- The operating theatre will have a balanced supply and extract so that it is at the same pressure as the corridor.
- Air should not cascade from the theatre to the surrounding rooms, so pressure stabilisers and/or transfer grilles should not be fitted. In the case of a convertible operating suite, permanently fitted hinge-down blanking plates with clamps should be provided to close the pressure stabiliser/transfer grille openings when required.
- The preparation room may be dispensed with to avoid having stock that could become pre-contaminated. Sterile packs, instruments and consumables would be delivered to the theatre on a case by case basis. If a preparation room is required, it should be maintained at 10 Pa to both the theatre and corridor.
- The anaesthetic room should have a supply in excess of extract so that is maintained at 10 Pa above both the corridor and the theatre. There should be a pressure stabiliser between the

anaesthetic room and the corridor but no transfer device between the anaesthetic room and the theatre.

- The scrub should have an active extract as for a conventional operating suite but no pressure stabiliser between it and the corridor.
- The utility should be at negative pressure of not less than –5 Pa to the theatre and its corridor.
- The corridor extract will be sized to cater for the air leakage from the preparation and anaesthetic rooms.

Overall, the ventilation scheme should ensure that all air supplied to the operating theatre is removed in the theatre. The theatre should be neutral (at the same pressure) to the corridor so that when the theatre exit door is open there is effectively no interchange of air between them. When the preparation or anaesthetic doors are opened, air flows from them into the theatre and not the other way.

8.126 The theatre control panel, automatic control strategy and air handling unit will be as for a conventional operating suite.

Interventional imaging suites

8.127 Interventional imaging refers to rooms in which surgical interventions are carried out guided by imaging equipment. The risk of infection by the airborne route is low as the surgical site is small, and sterile instruments tend to be unwrapped immediately before use. Anaesthetic gas or agents are used for pain relief or sedation.

Patients requiring full anaesthesia will normally be treated in a hybrid or conventional operating suite. The VSG should advise on the likely scope of use.

8.128 An interventional image suite may simply be a room containing the imaging equipment, an adjoining radiation protected control room or bay for staff and an equipment room for the imaging server. Support rooms for patient changing, sit recovery, toilets and a utility may also be needed.

8.129 Ventilation of the imaging room would be 10 ac/h with the room at a positive pressure to the corridor. Ceiling-mounted steelwork to support the imaging equipment may reduce the space available to install ventilation ductwork and compromise the supply terminal locations. This may mean that sidewall linear terminals are the only viable option. If fitted, their discharge velocity should not cause draughts and the direction vanes should be fixed or capable of being locked to prevent alteration during routine cleaning. Alternatively, a displacement ventilation scheme may be considered.

8.130 A full “theatre style” control panel is not required, but a green light to show the ventilation is operational and a red one to show it is not should be provided.

8.131 Radiation shielding and warning notices may be required to ductwork where it penetrates ceilings, walls or floors to plantrooms or adjacent spaces to which staff may need access.

Other application-specific design guidance

Table 2 Treatment and procedure facilities

Application: Bronchoscopy, Endoscopy, Dental and General treatment facilities		
Area/zone	**Reason for ventilation**	**Typical design factors**
Bronchoscopy procedure room	Control of exposure of staff to airborne pathogenic material discharged by the patient e.g. multi-drug-resistant tuberculosis (MDR-TB) during the procedure being undertaken. (COSHH Regs) Control of exposure of staff to waste anaesthetic agents when used. (COSHH Regs)	Establish a clean airflow path – Supply terminal at high level at foot end of patient's chair/couch and extract terminal at patient's head level behind the chair/couch. Design parameters Air change: 10 per hour Pressure regime: –5 Pa to corridor Noise level: 40 d(B)A Temp range: 20 to 25°C BMS control Humidity: Floating; max 70%RH Air quality: BS EN 16798 - SUP2 Extract discharge – Discharge in safe position away from people or open windows. If no suitable position available treat the discharge in the same way as a LEV with a discharge stack 3 m above the roof line.
Endoscopic procedure room	As above and odour control	
Dental treatment room	Control of exposure of staff to airborne pathogenic material discharged by the patient during the procedure being undertaken. (COSHH Regs) Control of exposure of staff to waste anaesthetic agents when used. (COSHH Regs)	Establish a clean airflow path – Supply terminal at high level and extract terminal at low level near patient's chair/couch. Design parameters Air change: 10 per hour Pressure regime: Neutral to corridor Noise level: 40 d(B)A Temp range: 20 to 25°C BMS control Humidity: Floating; max 70%RH Air quality: BS EN 16798 - SUP2
Emergency department resuscitation room	As above	
General treatment room	Comfort conditions only	

All of the above rooms are suitable for aerosol-generating procedures (AGPs)

Table 3 Airborne protective facilities

Applications: Level 2 and 3 critical care areas, bone marrow transplant (BMT), oncology, organ and tissue transplant units		
Area/zone	**Reason for ventilation**	**Typical design factors**
Note: Level 2 & 3 Critical care areas should be treated identically in terms of service provision as their only difference is the staff-to-patient ratio.		
Level 2 or 3 critical care individual room	Protection of patients from airborne organisms and fungal spores	Supply only in patient's room and cascade air out via door undercut, transfer grille or pressure stabiliser through rooms of a lower classification. Design parameters Air change: ≥10 per hour Pressure regime: +5 Pa to general area Noise level: 35 d(B)A Temp range: 20 to 25°C BMS control Humidity; Floating; max 60%RH Final filter; BS EN 1822 – EPA10
Level 2 or 3 critical care open bays	As above	
Bone Marrow Transplant (BMT) unit	Protection of patients from airborne organisms and fungal spores Note: Patient(s) will have a very poor immune system (neutropenia) so will be particularly vulnerable to infection by the airborne route.	Supply only in room and cascade air out via door undercut, transfer grilles or pressure stabilisers through rooms of a lower classification. Design parameters Air change: ≥10 per hour Pressure regime: +15 Pa to corridor Noise level: 35 d(B)A Temp range: 20 to 25°C BMS control Humidity: Floating; max 60%RH Final filter: BS EN 1822 – EPA12
Haematology/Oncology ward	As for BMT	
Organ and Tissue Transplant unit	As for BMT	

For individual room airborne protective isolation, see guidance on PPVL rooms given in Table 4.

See also Health Building 04-01 – 'Adult in-patient facilities' and Health Building 04-02 – 'Critical care units'.

Table 4 Airborne isolation facilities

Applications: Isolation rooms category 2 & 3, Infectious disease units, Containment level 3 rooms		
Area/zone	**Reason for ventilation**	**Typical design factors**
Category 2 isolation room Category 3 isolation room	Protection of staff and all other building occupants from airborne organisms dispersed by a patient with an infectious disease. See Health Building Note 04-01 Supplement 1	Extract only in patient's room and en-suite. Supply air from corridor passing into room via door undercut, transfer grille or pressure stabiliser. Alternatively the patient's room may have a supply and extract provided they are interlocked to ensure that the room is always at –ve pressure with regard to the corridor. Design parameters: Air change: ≥10 per hour Pressure regime: –5 Pa to general area Noise level: 35 d(B)A Temp range: 20 to 25°C BMS control Humidity: Floating; max 60%RH Air quality: BS EN 16798 – SUP2
Positive pressure ventilated lobby (PPVL) isolation room Universal isolation facility	Protection of building occupants from patients who may be infected and protection of patients who may be immunocompromised and protection for patients with both conditions. See Health Building Note 04-01 Supplement 1	Supply in lobby flowing through a pressure stabiliser to patient's room and on via a door undercut or transfer grille to an extract in the en-suite. Design parameters: Bedroom air change: ≥10 per hour Lobby pressure: +10 Pa to corridor Bedroom pressure: Neutral En-suite pressure: –ve Comfort parameters as above Air quality: BS EN 16798 – SUP2 With facility to fit BS EN 1822 – EPA12
Containment level 3 laboratory	Protection of occupants in adjoining spaces from airborne bio-hazards	For design details see the Medical Research Council's "Standards for containment level 3 facilities"
Category 4 facility	Design advice will be provided by the client	

See also Health Building 04-01 – 'Adult in-patient facilities' and Health Building 04-02 – 'Critical care units'.

Table 5 Maternity facilities

Application: Obstetrics theatre, delivery rooms, nursery, neonatal intensive care and special care baby units		
Area/zone	**Reason for ventilation**	**Typical design factors**
Obstetrics theatre	Protection of patients from airborne organisms and fungal spores. Control of exposure of staff to waste anaesthetic agents (COSHH Regs)	Ventilation design parameters as for a conventional operating suite. System should normally be at "set back" with a minimum temperature of 18°C and be able to attain full operating conditions within 5 minutes of triggering the system
Delivery room	Control of exposure of staff to waste anaesthetic agents. (COSHH Regs)	Establish a clean airflow path – Supply terminal at high level at foot end of bed and extract terminal at low level at head end of bed. Design parameters: Air change: 10 per hour Pressure regime: Neutral to corridor Noise level: 35 d(B)A Temp range: 20 to 25°C local control Humidity: Floating – max 70%RH Air quality: BS EN 16798 – SUP2
Delivery room with birthing pool	As for standard delivery room above	
Specials delivery room	As for standard delivery room above	
Nursery	Comfort conditions only	
Neonatal intensive care unit or special baby care unit (SCBU)	Protection of neonates from airborne organisms and fungal spores. Neonates are kept in incubators but may be removed for feeding, changing etc. so local temperature control and ensuring a draught-free environment is essential.	Standard supply and extract Design parameters: Air change: 10 per hour Pressure regime: +5 Pa to corridor Noise level: 45 d(B)A Temp range: 20 to 28°C local control Humidity: Floating – max 70%RH Air quality: BS EN 16798 – SUP1 (Filter grade depends on ODA category – see the Specialised Ventilation for Healthcare Society's (2018) SVHSoc.02)
N.B. This is a critical healthcare facility and consideration should be given to system resilience and/or how suitable alternative accommodation may be provided in the event of a ventilation system failure.		

Table 6 Pharmacy facilities

Applications: pharmacy aseptic suite, gene therapy, radiopharmacy, support rooms		
Area/zone	**Reason for ventilation**	**Typical design factors**
Aseptic suite Clean room	Protection of product during and after processing. Protection of the wider environment from cytotoxic agents and antibiotics. EUGGMP standards (European Commission, 2011) apply and the Medicine Act if the facility is licensed. Control of exposure by the airborne route to staff of substances during and after processing products. (COSHH Regs). Note: While this application is a critical facility, it is usual to have a plan in place to decant to another site in the event of a ventilation system failure	Supply only in clean room and cascade air out via pressure stabilisers through rooms of a lower classification or where there are multiple clean rooms, a balanced supply and stable cascade out. Thimble extract may be provided for class 3 safety cabinets depending on the location of room within the building. Note: Advice from the client's lead pharmacist should be sought prior to engaging in detailed design. Design parameters: Air change: ≥20 per hour Pressure regime: +15 Pa between unclassified rooms and +10 Pa between classified rooms Noise level: 45 d(B)A Temp range: 20–24°C BMS control Humidity: Floating – max 60%RH Final filter: BS EN 1822 – HEPA14
Gene therapy clean room	As above, plus protection of the wider environment from product	As per clean room above plus negative-pressure access lobby and controlled exhaust
Radiopharmacy clean room	As for standard clean room with additional requirements of the Ionising Radiation (Medical Exposure) Regulations	As per clean room above
Non-sterile stores and support rooms	Comfort conditions only	

Table 7 Sterile services

Application: Sterile services department, endoscope reprocessing unit		
Area/zone	**Reason for ventilation**	**Typical design factors**
Sterile services department, Inspection, assembly and packing room (IAP)	Protection of instrument from gross contamination during packing. EUGGMP standards (European Commission, 2011) apply and the Medicine Act if the facility is licensed. Note: While this application is a critical facility, it is usual to have a plan in place to decant to another site in the event of a ventilation system failure	Supply only in clean room and cascade air out via pressure stabilisers through rooms of a lower classification. Design parameters: Air change: ≥20 per hour Pressure regime: +15 Pa between unclassified rooms and +10 Pa between classified rooms Noise level: 45 d(B)A Temp range: 20–24°C BMS control Humidity: Floating – max 60%RH Final filter: BS EN 1822 – EPA10
Wash room	Control of exposure by the airborne route to staff of biological material liberated during the preliminary handling and washing of used surgical instruments (COSHH Regs)	–5 Pa to corridor Air change: 10 ac/h General extract and extract located along the rear of the wash bench and sinks.
Sterile pack store	To prevent casual airborne contamination of the outside of sterile packs	6 ac/h supply ventilation only +5 Pa above surrounding rooms
Non-sterile stores and support rooms	Comfort conditions only	
Used endoscope processing – wash room	Control of exposure by the airborne route to staff of biological material liberated during the washing of used scopes (COSHH Regs)	–5 Pa to corridor Extract air 10 ac/h Extract location along the rear of the endoscope wash bench and sinks.
Clean endoscope storage	To prevent casual airborne contamination of the outside of the scope	+5 Pa to corridor Supply 10 ac/h Pressure stabiliser located in wall above endoscope washer-disinfector discharging into wash room. Alternatively, see Health Technical Memorandum 06-01 Part C – 'Operational management' for guidance on how to store flexible endoscopes.
See Health Building Note 13 – 'Sterile services department' and Health Technical Memorandum 06-01 – 'Decontamination of flexible endoscopes'.		

Hydrotherapy: general requirements

8.132 In a hydrotherapy suite, heat recovery should be via a heat pump.

8.133 In general, the quantity of supply air should be calculated as 25 L/s/m^2 wetted surface, with the wetted surface taken as 110% of the pool water surface area. (See the Swimming Pool and Allied Trades Association (SPATA) for detailed guidance.)

8.134 A recirculation plant is recommended, with fresh air make-up to the standard required by the Building Regulations Part F – Non-domestic Buildings. In practice this may need to be increased to control condensation.

8.135 As far as practicable, recirculated pool air should be provided to the ancillary changing and recovery accommodation, with the only extract from the toilets, laundry/utility room and pool hall.

8.136 Supply air to the pool hall should be introduced at high level and directed towards the perimeter to mitigate condensation, with extract air taken from directly over the pool.

8.137 The ceiling void above the pool may need to be ventilated to prevent condensation.

Control of hydrotherapy pool installations

8.138 The supply and extract fans should be interlocked so that the supply fan does not operate until flow is established within the extract system.

8.139 Time-clock control should be provided, with a local override switch to extend the normal operating period as required.

8.140 Night set-back temperature (in the range of 21–25°C) and high humidity control (in the range of 60–75% sat) should be provided to override the time clock in order to prevent condensation. The exact set points should be ascertained post-installation.

8.141 A remote indication panel should be provided in the pool hall, giving a visual display of the pool water and pool air temperature.

Extract systems

LEV systems

8.142 Devices that use an inflow of air to control exposure of staff to hazardous substances are classified as local exhaust ventilation (LEV) systems under the COSHH Regulations. Note that the supply or make-up air to a room containing an LEV system may itself be considered to be a part of the LEV system.

8.143 An LEV system may comprise a self-contained unit incorporating its own carbon filter such as a simple bench-top fume cupboard. Alternatively, it may be a complete “ventilation system” comprising a make-up air supply, multiple exhaust protected workstations, branch and central extract ductwork, duplex extract fans and a high-level discharge terminal. It may also incorporate a special filtration system appropriate to the hazardous substance being controlled. Such systems could be required for workshops containing woodworking machinery or large centralised pathology laboratories housing multiple safety cabinets, cut-up benches, fume cupboards and specimen stores.

8.144 It is important to recognise at the design stage whether an extract is being provided for comfort, to remove odours or as an LEV system. Typical LEV systems in healthcare include:

- microbiological safety cabinets and containment level 3 rooms;
- fume cupboards;
- welding fume extracts;
- woodworking-machinery duct collectors;
- lead-acid battery charging-bay extracts;
- powered plaster and bone saws;
- pharmaceutical preparation cabinets and tablet machines;
- dissection benches, cut-up tables and some specimen stores;
- medium- and high-risk infectious diseases isolation facilities;
- dental furnaces, grinders and polishers.

Note:

Post-mortem tables may incorporate downflow peripheral ventilation but unless otherwise specified by the equipment supplier, their ventilation is only provided to control odours.

8.145 Information on the design of ductwork, fan and discharge stack arrangements will be applicable to all types of LEV system and is given in Chapter 9.

8.146 LEV systems are statutory items that will be subject to an independent examination and test at least every 14 months by a competent person holding an in-date P601 certificate.

Note:

For AGSS, see Health Technical Memorandum 02-01.

Bench extract systems

8.147 Bench extract ventilation is required in departments such as pathology and mortuary, where activities involve the release of malodorous or toxic fumes which should not be inhaled. They may also be required in sterile services departments and wash-rooms within endoscope reprocessing units to remove airborne biological material liberated when the used items are given a preliminary clean.

8.148 In all cases bench extract systems that create an airflow from the front to the rear are preferred over those that rely on a downflow of air through a perforated surface, as the airflow is easily obstructed when in use.

Typical arrangements

8.149 Each ventilated position will usually be accommodated in a continuous run of benching, which should not be more than 650 mm from front to rear and which should be provided with a continuous upstand at the rear. Each position should have a 1200 mm × 150 mm linear extract grille mounted on a purpose-designed plenum box (incorporating guide vanes as necessary), with its face flush with the upstand. The bottom of the grille should be as close as practicable to the level of the working surface (usually 75 mm above, to allow for cleaning). The minimum velocity across any part of the grille should be 1 m/s. The grille should be readily demountable to allow for cleaning.

Control of bench extract systems

8.150 Provided that it does not interfere with the operation of the department when not in use, the ventilation system for the bench extract and any associated supply may be shut down. However, a run-on timer with a minimum setting of 30 minutes should be provided. To this end, local control should be provided.

8.151 Processes that produce hazardous vapours, fumes, dusts or noxious vapours should be enclosed or semi-enclosed in a suitable cabinet or exhaust-protected workstation (LEV).

Microbiological safety cabinets and fume cupboards

8.152 Safety cabinets and fume cupboards are devices that have an inflow of air to control exposure of staff to hazardous substances. The units and their exhaust systems, filters, fans and discharge terminals are all classified as LEV systems under the COSHH Regulations. The make-up air system to a room that contains an LEV system may also be considered as an essential part of the system and be included in the LEV classification.

Special requirements

8.153 The supply air system should not distort the unidirectional and stable air pattern required for fume cupboards and microbiological safety cabinets. In general, supply air ceiling diffusers should not discharge directly towards fume cupboards or safety cabinets, unless the terminal velocity is such that the airflow pattern at the front of the cabinet is unaffected. The design should ensure that high air-change rates, and/or the opening and closing of doors, do not have any adverse effect on the performance of safety cabinets or fume cupboards. A damped door closure mechanism may help.

Arrangements for safety cabinet installations

8.154 The manufacture and installation of microbiological safety cabinets will be in accordance with the relevant national standards and guidance issued by the Advisory Committee on Dangerous Pathogens (ACDP).

8.155 A Class 1 microbiological safety cabinet will be specified for routine work involving Group 3 pathogens. It should be housed in a containment level 3 room. Specific design information on containment rooms is issued by ACDP in conjunction with the Health and Safety Commission.

8.156 Siting and installation of microbiological safety cabinets are of particular importance because:

- the protection afforded to the operator by the cabinet depends on a specific and stable unidirectional airflow through the open front;
- the protection to the environment by the cabinet depends on the high-efficiency particulate air (HEPA) filters. The exhaust air should never be considered as totally free from microbiological hazard.

8.157 Microbiological safety cabinet extract is HEPA filtered prior to being discharged to outside. Current standards permit the installation of microbiological safety cabinets with integral fans, provided that the extract ductwork can be kept short (that is, less than 2 m); such an installation, however, is likely to be noisy and is not recommended for use in new buildings.

8.158 Ductwork and discharge arrangements should be as set out in Chapter 9.

8.159 Discharge should be to outside but where this is impracticable, discharge into the room via a double HEPA filter will be accepted if approved in writing by the VSG.

Arrangements for fume cupboard installations

8.160 The manufacture and installation of fume cupboards will be in accordance with the relevant national standards and associated guidance.

8.161 The primary factors which contribute to the effective performance of fume cupboards include:

- an adequate volume of supply air and its means of introduction;
- an effective exhaust system to promote the safe dispersal of waste products to atmosphere.

8.162 The air velocities through sash openings should be enough to prevent hazardous materials from entering the laboratory while avoiding excess flow rates that interfere with the investigation process. Average face velocities should be between 0.5 and 1 m/s, with a minimum at any point within 20% of the average, the upper end of the range being applicable to the containment of materials of high toxicity. The design velocity should be maintained irrespective of whether the sash opening is varied, or whether doors or windows are open or closed (see BS EN 14175).

8.163 The possibility of a fire or explosion which may not be contained by a fume cupboard should always be considered. A fume cupboard should not, therefore, be sited in a position where exit to an escape route will necessitate passing directly in front of it.

Control of extract systems

8.164 It is desirable to provide local control of safety cabinets in order to maximise the life of the HEPA filter, and to permit the sealing of the cabinet and room for fumigation if spillage occurs.

8.165 To cope with the risk of an accident or spillage outside safety cabinets, a panic button should be provided to switch off the supply to that area and to discharge all extracted air to atmosphere.

8.166 In pathology departments, it will always be necessary to have one or more microbiological safety cabinets and one or more fume cupboards available for use, including weekends; therefore, local overriding controls for all these items and any associated ventilation plant will be necessary.

Hood extract systems

Special requirements

8.167 Extract canopies will be required over steam-and-heat-emitting appliances, for example sterilisers, catering and washing equipment and for the extraction and removal of unpleasant odours. These installations are for the control of non-hazardous airborne contaminants, they are not LEV systems.

8.168 Perimeter drain gulleys and corrosion-proof grease eliminators should be provided on kitchen hoods (see BESA DW 172 – 'Specification for kitchen ventilation').

Typical arrangements

8.169 The airflow rate should be enough to ensure an adequate capture velocity in the vicinity of the process. Advice from equipment suppliers should be sought, as excessive velocities will be wasteful of power and generate noise.

8.170 The lowest edge of the canopy should be 2 m above finished floor level, with a minimum of 300 mm overhang beyond the edge of the equipment on all sides.

8.171 A compact arrangement of equipment (but with access for maintenance) will minimise the canopy area, and hence reduce the air volume necessary to achieve the optimum capture velocity.

8.172 Hoods required for the control of heat gain and vapours may be connected to the general extract system when it is convenient to do so, but where non-

corrosive ductwork materials are necessary, a separate extract system is preferred.

8.173 Lighting and internal divider plates are often required to be built into the perimeter of large canopies; however, built-in shelving systems are not recommended, as they interfere with the airflow, and constitute a maintenance problem.

Control of hood extracts

8.174 Provided that it does not interfere with the operation of the department when not in use, the ventilation system for the hood extract and any associated supply may be shut down. To this end, local control should be provided.

Plantroom ventilation

General requirements

8.175 Plantrooms are required to be ventilated in order to maintain acceptable temperatures for satisfactory operation of the plant and controls, and for maintenance activities. Natural ventilation through louvred openings protected from infestation by a mesh with openings of no less than 6 mm and no more than 12 mm are required. Powered plantroom ventilation should only be needed if natural ventilation is not adequate.

8.176 Ventilation requirements should consider all heat sources within a plantroom, and where there are large glazing areas, solar gains. The ventilation rate should limit the maximum temperature within the plantroom to 32°C.

8.177 Air handling equipment cannot be located in a fire compartment that houses combustion equipment.

8.178 AHUs and other ventilation equipment that serve occupied areas cannot draw their intake air from a plantroom. Neither should extract ventilation plant or medical vacuum pumps discharge air into a plantroom.

8.179 Statutory regulations for plantroom ventilation are contained in the Building Regulations, and further guidance in the CIBSE Guide B2. Note the need to assess the risk of services to AHUs freezing in unheated plantrooms.

9.0 Equipment selection factors

General requirements

9.1 The following gives detailed guidance on the design and selection of ventilation equipment, the distribution system, terminals and control aspects. Designers should take note of the supporting information given in Chapters 10 and 12. Failure at the design stage to make due allowance for the standards to be achieved may mean that the installed ventilation system will not be acceptable to the client's validator at handover.

Location and access

9.2 The plant should be located so that it is remote from possible sources of contamination, heat gains and adverse weather conditions. The design should ensure that wind speed and direction have a minimal effect on plant throughput.

9.3 Safe access to and around plant is essential to facilitate inspection, routine maintenance, repair and plant replacement.

9.4 Air-handling units (AHUs) should be located in an accessible area secured from unauthorised entry. They may be grouped together in dedicated plantrooms or distributed around the building with AHUs located adjacent to or within the area that they serve. In the healthcare setting, because of the difficulty in gaining access for routine service and maintenance, mounting ventilation units of any type in ceiling voids above clinical spaces is not permitted.

Note:

If it is proposed to install ventilation units of any type in a ceiling void above a non-clinical area, it should be subject to a formal risk assessment and its use being agreed by the ventilation safety group (VSG) prior to design approval. Their assessment will consider how the unit may be safely accessed and maintained.

9.5 AHUs should be located in purpose-built plantrooms or designated service spaces within a building. This will allow for routine service and maintenance (which is a statutory requirement) to be carried out at any time of day and regardless of weather conditions. It will also protect the plant from contamination by bird droppings, so reducing the risk of fungal spore contamination of the air supplied by the AHU. Control of pests and vermin will be simpler and while not in themselves a source of airborne contamination, their corpses can become a reservoir of biological material that may lead to insect infestations within the AHU.

Note:

In a new building it is not envisaged that there will be any need to locate AHUs outside. The design of the building should incorporate central or distributed plant spaces of sufficient size to accommodate the plant required to service the building.

9.6 When refurbishing or changing the use of an existing building, plant space should be created to house the ventilation plant and other services. If located on a roof they should be enclosed in a plantroom with a safe means of access. If located at ground level they should be secured within a plantroom to prevent unauthorised access. Measures should be taken to exclude vehicles from the vicinity to ensure that exhaust fumes will not be drawn into intakes. Intakes for ground level AHUs should be extended to a height and distance from contamination sources that allows them to draw in unvitiated air.

9.7 In the unlikely event that an internal or external plantroom cannot be provided, and ventilation units have to be located outside, they should be fully weatherproof to IP65 and secured from unauthorised access. Protection against the elements should also be provided for personnel carrying out routine inspection and maintenance activities. As an example, when two units are outside, and they are installed with their access doors facing each other, if the gap between them is roofed over and the open ends capped, the AHUs themselves create what is in effect a plantroom (see photographs).

9.8 Water will be used during routine cleaning or spilt when maintenance is being undertaken. The area around plant should be tanked to prevent water penetration to adjacent areas and adequately drained.

AHU formed plantroom (external)

AHU plantroom (internal)

Note:

Plantrooms should be provided with a sink so that glass drainage traps may be cleaned out and staff can wash their hands after handling contaminated/dirty filters. A source of domestic hot water (DHW) with a valved hose connection point will also be required so that AHUs can be washed out internally as part of their routine maintenance. Plantrooms at roof level should be served by a lift.

9.9 Fire precautions should be incorporated in accordance with the Health Technical Memorandum 05 Firecode series. Guidance is available in Chapter 1 of this document.

9.10 Combustion equipment cannot be located in a fire compartment that houses air handling equipment.

Standard requirements

Identification and labelling

9.11 All ventilation systems should be clearly identified with a permanent (traffolyte type preferred) label in accordance with the requirements of Chapter 13. The label should identify both the AHU and the area that it serves. The lettering should be at least 100 mm high and be screwed or riveted onto the AHU in an easily visible place near the fan of the unit, adjacent to the local electrical isolator. Any subsystems and the principal branch ducts should be similarly labelled.

Note:

The AHU identification code should conform to the plant identification system in use at the premises (see Chapter 13).

9.12 The nature of air and direction of flow should be clearly marked on all ducts using the symbols given in BS 1710.

9.13 All airflow test-points should be clearly identified with a permanent label and the design information given (for example, TPS 1 – Anaesthetic supply; 400 × 300; Design 185 L/s).

Plant minimum standards

9.14 Plant should comply with the minimum standards set out in Table 8.

9.15 External finish to be corrosion resistant and may be available in a variety of colours at no additional cost. This can aid identification by colour-coding of units in a plantroom (for example, green for general ventilation; blue for theatres; red for laboratories and isolation facilities; grey for extract).

9.16 Organic materials or substances that can support the growth of microorganisms cannot be used in the construction of the plant or its distribution system. The water fittings and materials directory list suitable materials for sealants and gaskets (see also BS 6920).

9.17 AHU internal wiring should comply with BS 7671 and be installed in a cable containment system providing suitable mechanical protection. The wiring and its containment system should not allow air bypass at the filters. The wiring, its containment system, connection boxes and fixings should permit the effective internal cleaning and inspection of the AHU.

9.18 Plastic-bladed dampers and plastic plate heat exchangers should not be fitted. This accords with the national policy to reduce the use of plastics.

9.19 Motorised spring-return low-leakage (BS EN 1751 class 3) isolation dampers should be located at the intake, supply, return air and discharge duct connections of an AHU and associated extract unit. They should be of the opposed-blade type and be fitted with end switches. They should close automatically in the event of power failure or plant shutdown to prevent any reversal of the system airflow. They will also function to isolate the plant from the distribution system when undertaking cleaning or maintenance.

Note:

Internal plant dampers or provision for the fitting of shut-off plates, also known as dagger plates, between elements within an AHU are not required.

9.20 Access to elements that require routine service such as filters, fans and all types of heat-transfer device should be via hinged doors. In horizontal units the doors should be wide enough: 500 mm minimum at a unit height >1 m. For smaller units the doors need to be at least 600 mm wide, to allow easy access. Items requiring infrequent access such as attenuators may

Table 8 Plant minimum standards

AHU Element	Minimum Standard	Notes
Construction	Double metal or composite skin with sandwiched insulation to "Euroclass A" fire rating Smooth internal surface without channels or ridges No projecting spire or tech screws inside the unit.	Note: Capping projecting spire screws is not acceptable.
Internal surface finish	Non-corrodible, washable and smooth and of a colour that allows accumulations of dirt to be easily seen	Stainless steel or white powder coated mild steel or with an equivalent protective treatment; but NOT surface galvanised
Thermal transmittance	BS EN 1886 Class T2	Manufacturer's declaration
Thermal bridge	BS EN 1886 Class TB2	Manufacturer's declaration
Deflection	BS EN 1886 Class D2	Manufacturer's factory test
Factory airtightness test – pre-delivery	BS EN 1886 Class L2	Test at +700 Pa and –400 Pa
Site airtightness test	BS EN 1886 Class L2	+700/–400 Pa
Filter frame bypass leakage	BS EN 1886 Section 7	
Supply and extract intake and discharge isolation dampers	BS EN 1751 C3 (low loss)	Motorised opening and fitted with an end switch and spring return
Access doors	Secured from casual access. Fan chamber doors to be fitted with a two-stage latch	Key or similar device required to open access doors Door hinges should be adjustable to so that leakage can be eliminated on site
Specific fan power -Internal (SFPint)	Current Eco design requirement for energy-related products (ErP)	EU 1253 – 2014
Specific fan power - System (SFPsyst)	UK Building Regs	Part L2
Energy recovery	Current ErP EU 1253	Run-around coil – 68% Heat pipes – 73% Plate heat exchanger – 73% Thermal wheel – 73% Heat pump – EU 2281/201 Any other device – see standard

be via removable panels fitted with lifting handles, or access hatches. All doors and panels should be secured from casual access, close-fitting and without leaks.

9.21 All access doors should be fitted with seals and have adjustable hinges so that leakage can be eliminated once the unit is installed on site. Access doors to fan chambers should have a two-stage opening sequence to prevent the door blowing violently open if it is unlatched while there is still residual pressure in the unit.

Note:

Providing the AHU is located in a plantroom or area secured from unauthorised entry, its access doors can only be opened with a key or similar device, the fan door is fitted with a viewing port and a two-stage opening latch and there is a fan electrical isolation switch adjacent to the fan-chamber access door, there is no requirement to fit an internal fan chamber mesh guard.

9.22 In the healthcare setting it can be difficult to turn off AHUs in order to inspect filters and drainage trays. Viewing ports and internal illumination will therefore facilitate routine inspection of such items. Viewing ports should be at a convenient height so that temporary ladders are not required. In double-stacked units the viewing ports in the upper section will be located in the lower portion of their access doors. Internal illumination should be provided by fittings to at least IP55 rating. Light fittings should be positioned inside the unit (not on the access doors) so that they provide illumination for both inspection and task lighting. All lights in a unit should be operated by a single switch and be powered independently of the AHU main switch. LED lights are preferred.

9.23 Access to air intakes and discharges, AHUs and items in the distribution system such as filters or auxiliary trimmer batteries located in a plantroom or plant area above 1.5 m should be via platforms, fixed ladders, hook ladders, pulpit style movable steps or access platforms. The method of access chosen should reflect the frequency and nature of the maintenance requirement. The installation of distribution ductwork and other electrical or mechanical services should provide sufficient clearance to allow access equipment to be moved into position.

Chiller units: heat rejection devices

9.24 The design conditions given in Chapter 8 make no allowance for the elevated temperatures that can occur on the roof of buildings. Refrigeration condensers and chiller units should, if practicable, be shaded from direct solar radiation, or the design adjusted to take account of the gain. Care should be taken to ensure that there is sufficient clearance around the plant to allow effective air movement. Allowance may also be needed for the effect of walls, obstruction or other equipment in the area and for the prevailing wind direction.

9.25 Air-cooled condensers and/or dry coolers will always be the first choice for heat rejection from any refrigeration plant. The use of heat pump systems is also an option. Wet evaporative cooling systems cannot be used in healthcare premises unless limitations of space mean that they are the only way that the cooling load can be met. If they are used, national guidance on preventing and controlling *Legionella* should be closely followed (see the Health and Safety Executive's (HSE) Approved Code of Practice and guidance document HSG274 'Legionnaires' disease: the control of *Legionella* bacteria in water systems').

9.26 Traditional refrigerants are being phased down and some of their replacements at the time of writing have a degree of flammability. The level of risk this poses should be formally addressed at the design stage and agreed with the client or their fire safety representative. The selection of a refrigerant should be made with reference to the F-Gas Regulations and should take account of the life expectancy of the plant versus the future availability and increasing cost of the refrigerant. Ultimately, choosing refrigerants with the lowest global warming potential is the ideal and will ensure that greenhouse gas emissions are minimised.

Chiller selection: size and resilience

9.27 There is a tendency to meet the calculated maximum chiller load by specifying multiples of a standard size of chiller (for example, the calculated load to be met by three chillers each capable of 33% and an extra chiller of the same size to achieve the N+1 resilience requirement). This approach does not lend itself to efficient operation. It is preferable to split the load with, for example, two chillers capable of 40% each and two capable of 25% each. This will give an overall minimum

capacity of 90% resilience at maximum summer design conditions and allow for the actual part load demand to be met in the most energy-efficient way.

Supply AHUs and associated extract units

Typical sequence of components

9.28 The AHU should be arranged so that most of the items are under positive pressure. Cooling coils and humidifiers will require a drain and should be on the positive pressure side of the fan. The following arrangement of components is typical, although in many instances not all elements will be required:

- fresh air intake;
- motorised isolation damper;
- fog coil if energy recovery fitted or frost coil if no energy recovery fitted;
- pre-filter;
- energy-recovery device (possible location);
- attenuator[1];
- supply fan;
- attenuator[1];
- energy-recovery device (possible location);
- cooling coil;
- eliminator (for face velocities above 2 m/s);
- heater-battery;
- humidifier (if required);
- final filter;
- motorised isolation damper.

9.29 AHUs may be configured as horizontal, linear single or double-stacked; or as cabinet type units. For double-stacked supply/extract units, the fans should be located on the bottom deck where possible as it will make them simpler and safer to change (see Figures A1–A3 in Appendix 1 for possible arrangement.)

Intakes and discharges

9.30 Air intakes and discharge points should preferably be located at high level, to minimise the risks of noise nuisance to surrounding buildings, contamination and vandalism.

9.31 Intakes and discharges should be designed and located so that wind speed and direction have a minimal effect on the plant throughput.

9.32 Helicopter landing pads in the vicinity of ventilation intakes and discharges can result in large short-term pressure changes. This can cause pressure surges in supply systems and reverse airflows in extracts. Exhaust fumes from the helicopter may also be drawn into intakes.

Note:

It is not appropriate to "plan to turn the ventilation off when a helicopter lands" as a means of permitting the location of a helipad adjacent to ventilation intakes and discharges.

9.33 Intake points should be situated away from cooling towers, heat sources, boiler flues, vents from oil storage tanks, fume cupboards and other sources of contaminated air, vapours and gases and places where vehicle exhaust gases may be drawn in.

1 Attenuators may be located in the intake and discharge duct if they are of a suitable type and provided with cleaning access both sides (see paragraph 9.116).

Note:

Steps should be taken to prevent birds landing or roosting in the vicinity by removing ledges or fitting anti-pigeon spikes.

9.34 On the rare occasions where intakes have necessarily to be sited at or near ground level, the surrounding area should be paved or concreted to prevent soil or vegetation being drawn in. They should be caged or located within a compound to restrict unauthorised access and prevent rubbish being left in the vicinity. The likely proximity of vehicle exhausts should also be taken into account when determining the protected area around the intake and additional filtration may be required. The VSG should be consulted about the standard of air quality required. There should be a minimum 4 m clear zone around the intake (see paragraph 9.50 and paragraphs 9.63–9.64).

9.35 The discharge from an extract system will be located so that vitiated air cannot be drawn back into the supply air intake or any other fresh air inlet. Ideally, the extract discharge will be located on a different face of the building from the supply intake(s). At all times, there has to be a minimum separation of 4 m between them, with the discharge mounted at a higher level than the intake.

Note:

Ventilation intakes and discharges cannot face each other across a passageway or courtyard even if they are 4 m or more apart.

9.36 Each intake and discharge point should be fitted with a corrosion-resistant weatherproof (BS EN 13030 class B) louvre or cowl to protect the system from driving rain. Louvres should be sized based on a maximum face velocity of 1.5 m/s in order to prevent excessive noise generation and pressure loss.

Note:

If there is a bend in the ductwork directly behind a louvre, it will affect theair velocity through the louvre. This may result in moisture carry-over or increased noise.

9.37 The inside of the louvres should be fitted with a mesh of not less than 6 mm and not more than 12 mm to prevent infestation by vermin.

9.38 The duct behind a louvre should be self-draining. If this is not practicable, it should be tanked and provided with a drainage system.

9.39 Cleaning access should be provided either from the outside via hinged louvres or by access doors in the plenum behind the louvre. Where a floor-level common plenum is provided, cleaning access should be via a walk-in door. High-level plenums should be able to be safely accessed by temporary or permanent means.

Note:

Builders' work plenums or intake ducts will need to have a smooth finish and be surface-sealed to prevent dust shedding (see paragraph 10.5).

Fans

9.40 Direct-drive electronically commutated (EC) fans are the preferred choice for ventilation systems. If necessary, resilience and an increased capacity can be achieved by installing two or more EC fans with gravity or motorised dampers to prevent backflow.

Note:

At the time of writing the concept of a "fan wall" made up of multiple small variable speed fans all controlled as a single unit was under development. This concept has several advantages as the failure of one fan can be accommodated by speeding up the rest. Because the fans cover the full area of the duct, it will result in a more uniform air velocity downstream at the battery face. This will increase the heat transfer efficiency and may allow a reduction in battery size. Nothing in this document will preclude the use of such innovation that improves resilience and reduces energy usage.

9.41 For an application outside of the capacity range of EC fans, direct-drive plug fans controlled by an inverter mounted externally to the air stream may be selected.

9.42 In either case, the fan motor will be protected with a high-temperature safety cut-out.

9.43 Whichever type of fan is selected, if it serves a critical area it will be fitted in a way that allows it to be changed within 20 minutes. Mounting the fan unit on slide rails with plug and socket connections for power and control cables will facilitate this. Whenever possible, both supply and extract fans should be located on the bottom deck of a double-stacked AHU.

9.44 Selecting fans from a preferred size range will reduce the number of spares held.

9.45 Belt- and pulley-driven fans should not be installed in healthcare ventilation systems.

9.46 Supply fans should be positioned to blow through the central plant so that the cooling coil and humidifier drains (when fitted) will be under positive pressure. The energy-recovery device may be either side of the fan and should have a drainage system on the extracted air discharge side.

9.47 In extract systems where the air is potentially contaminated, explosive, aggressive or has a high moisture content, the extract fan motor will be located outside the air stream and be capable of being changed without the need to access or change the fan impeller.

Control

9.48 Where two or more fans are fitted in a fan wall, the preferred normal operation is all fans running in parallel. In case of a single fan failure the remaining fan(s) should provide at least 80% of the design output.

9.49 For most healthcare applications, the fan output should be set to give a constant volume of air. This should be controlled by measuring the pressure drop across the fan suction nozzle using a sensing ring and associated volume controller that will automatically integrate the fan K factor to determine and control the preset output air volume. The fan output will then in air volume terms remain constant regardless of changes of system resistance. The actual volume delivered will be related to the air-change rate for the application.

Note:

Measuring the air pressure in the main supply duct and using that to set the supply fan speed as a percentage of its rated output and using that to set the extract fan speed as a percentage of the supply fan speed is not a satisfactory, accurate or an acceptable way of controlling the desired supply and extract air volumes.

Filters

9.50 The purpose of filtration is to reduce the level of airborne contamination in an

air stream. It is generally carried out in stages.

9.51 Filters should be securely mounted in well-fitting frames designed so that the airflow pushes the filter into its housing to minimise air bypass. Vertical supports with seals should be provided to master the joints between filters and eliminate bypass. Mounting frames that withdraw so that the filter can be changed without having to reach into the unit are preferred.

9.52 Filters need to be readily accessible, so a hinged access door should be provided. The upstream side of the filter should be visible for inspection through a viewing port with internal illumination.

9.53 For AHUs, provided that each filter's pressure drop is monitored by a sensor linked to the BMS, direct reading gauges or manometers will not be required. Capped pressure tappings should be provided so that a portable manometer can be connected for diagnostic purposes when necessary.

9.54 General air filters (see Table 9) are divided into four categories, related to the size of particle (in microns (μm)) that they can remove as a percentage of the load.

- coarse filters – remove less than 50% of 10 μm particles;
- PM10 medium filters – remove 50 to 95% of 10 μm particles;
- PM2.5 medium filters – remove 50 to 95% of 2.5 μm particles;
- PM1 fine filters – remove 50 to 95% of 1 μm particles.

Table 9 General filters: typical healthcare selections

ISO 16890 Class	Notes and typical healthcare application
ISO Coarse 60%	May be used as temporary addition filtration at an air intake when building or demolition works are being undertaken in the vicinity
ISO ePM10 ≥50%	Panel pre-filter or return air filter to protect the energy-recovery device
ISO ePM2.5 ≥50%	Supply air filter for areas with temporary occupancy
ISO ePM1 ≥50%	Supply air filter for areas with permanent occupancy

Note:

Ventilation filters can only remove particles from the incoming air. Most particles that could cause an infection originate from the occupants and activities within the building. In AHUs the pre-filter and return air filter will keep the energy-recovery device, cooling coil and heater-batteries clean and working efficiently. The secondary filter will keep the distribution ductwork and supply air terminals clean.

Note:

For additional information on filter selection and indoor air quality, see the Specialised Ventilation for Healthcare Society's (2018) SVHSoc.02 – 'Change in air filter test and classification standards'.

9.55 In areas of high atmospheric pollution, a higher standard of filtration may be required in order to meet the indoor air quality standard (IAQ).

9.56 Compact filters are preferred, because bag filters are often incorrectly oriented and prone to damage when changed.

Efficiency and high efficiency particulate air (EPA and HEPA) filters

9.57 These filters are designed to provide filtration of particles in the sub-micron size range. EPA and HEPA filters self-select the particle that they are least able to trap and are graded against that "most penetrating particle size" (MPPS) (see Table 10):

- efficiency particulate filters (EPA): three grades E10 to E12;

- high efficiency particulate filters (HEPA): two grades H13 to H14;
- ultra-low particulate air filters (ULPA): three grades U15 to U17.

Table 10 EPA and HEPA filters: typical healthcare selections

Typical healthcare application	Minimum filter grade to BS EN 1822 – 2019* (Eurovent grade)	% Efficiency @ MPPS
UCV theatre terminal	EPA – E10 – (EU10)	85
–	EPA – E11 – (EU11)	95
Immunosuppressed and neutropenic patient rooms or wards	EPA – E12 – (EU12)	99.5
–	HEPA – H13 – (EU13)	99.95
Pharmacy aseptic preparation facility supply Containment level 3 room extract	HEPA – H14 – (EU14)	99.995

*Incorporates ISO 29463 tests methods.

Note:

ULPA filters are designed to remove particles below a size that is either surgically or aerobiologically significant. There would have to be exceptional circumstances in order to justify their use in a healthcare ventilation system.

9.58 EPA and HEPA filters are expensive, so their use should be kept to a minimum. When used they should be of the replaceable panel type with leakproof seals and installed in a manner that permits the validation of the filter and its housing (see Chapter 12).

9.59 In supply systems an EPA or HEPA filter will have a non-shedding metal case.

Return air and extract air filters

9.60 Return air filtration will always be required where heat recovery devices are installed. Return air filters are also used to reduce the load on EPA filters in recirculating applications such as ultra clean operating suite ventilation canopies and pharmacy aseptic preparation facilities. They should be the same grade as their AHU pre-filter.

9.61 EPA or HEPA filters are sometimes fitted in extract systems to capture hazardous substances or organisms. Design provision should be made for the subsequent safe handling of contaminated filters by maintenance staff. This may be achieved by:

- sealing the hazardous substance into the filter before it is removed;
- providing a system to fumigate the filter to kill any organisms;
- housing it in a "safe change" unit that permits the filter to be ejected into a bag and sealed without personnel having to come into direct contact with it.

Notes:

1. In view of the costs and problems associated with placing EPA or HEPA filters in extracts, it is essential that a full risk assessment be carried out at the design stage. This should include defining the true need for a filtered extract, the validation of its performance at installation, the method of safely changing a contaminated filter, and its subsequent disposal.
2. General extracts from mortuaries and post-mortem rooms may contain odours, but these are not in themselves hazardous to health and do not require filtration prior to discharge. In high-risk post-mortems (for example, known or suspected tuberculosis cases), the infected organs will be removed and then dissected in a class 1 microbiological safety

cabinet provided under the COSHH Regulations.

Extracts from infectious disease Isolation rooms or wards do not normally require filtration prior to discharge. However, if the discharge cannot be made in a safe location and it is likely that thevitiated air could be drawn back into the building or there are people in its vicinity (for example, a discharge into a courtyard), filtration would be required.

9.62 Extract EPA or HEPA filters should have a particleboard or plywood case so that they can be incinerated.

Activated carbon filters

9.63 Activated carbon filters can remove gases and vapours from an air stream and are graded according to the range of substances they can remove. They are not normally fitted in air-conditioning supply systems. They are occasionally fitted retrospectively because an air intake has been poorly sited and is drawing in noxious fumes or the outdoor air quality is exceeding WHO levels for NOX/O_3 or SOX. Where used they should be protected by or incorporated into a particulate air filter.

Note:

For additional information on filter selection and indoor air quality, see the Specialised Ventilation for Healthcare Society's (2018) SVHSoc.02 – 'Change in air filter test and classification standards'.

9.64 Activated carbon filters are more commonly used in specialised fume extraction systems when the location of the discharge means that dilution cannot be relied upon to disperse noxious fumes.

Energy-recovery devices

General requirements

9.65 Energy recovery will be fitted to all supply and extract healthcare ventilation systems. It may be omitted only where permitted by the current ErP Directive EU 1253/2014.

9.66 For most systems in healthcare premises, a plate heat exchanger, "run-around coil" system or thermal wheel would be appropriate. Selection should be based on the relative locations of the supply and extract units, ease of maintenance and practicality. Cleaning access will be required to both sides of any energy-recovery device.

Note:

Plate heat exchangers are the preferred option as they require the least maintenance to retain their energy transfer efficiency. Thermal wheels may be used, as the degree of air transfer from extract to supply is not sufficient to cause aerobiological problems and in any event the air will be filtered before being supplied to the user. Run-around coils are used when the supply and extract units are separate or in case of space problems.

9.67 At the time of writing, the following are the minimum energy transfer efficiencies required under EU 1253 for devices handling equal air volumes:

- run-around coil – 68%;
- plate heat exchanger – 73%;
- thermal wheel – 73%;
- heat pipe – 73%;
- heat pump or any other device – see specific regulations.

Note:

These efficiencies are regularly reviewed and are likely to be increased periodically.

9.68 If a plate heat exchanger is chosen, the plates should be constructed of metal; in coastal areas stainless steel is preferred. Plastic should not be used for the plates, internal bypass dampers or gears. (This is in keeping with the reduction in the use of single use plastics.)

9.69 If a thermal wheel is selected, only a sensible heat wheel should be used that incorporates a purge sector. In order to reduce bypass leakage, brush seals should not be used; enhanced airtightness seals should be fitted.

9.70 Whichever energy-recovery device is chosen, the extract side should be protected by at least an ISO ePM10 ≥50% filter and provided with a drainage system as described in paragraphs 9.105–9.112, to remove condensate. Note that most condensate will occur at intermediate rather than at extreme outside air conditions.

9.71 The energy-recovery device should be located downstream of the fog coil and pre-filter, before the cooling coil and main heater-battery. It may be on either side of the supply fan.

9.72 It is essential to consider the set points and control of the fog coil, energy-recovery device, cooling coil and heater-battery in order to achieve the most efficient operation for the maximum time. The primary energy provided by the fog coil will directly reduce the heat exchange of the energy-recovery device. To this end, the off-coil setting of the fog coil should be the minimum possible to keep the pre-filter dry (2 to 3 K above intake air temperature) (see paragraph 9.75 onwards for further guidance).

9.73 The energy-recovery device should be controlled in sequence with the main heater-battery and should incorporate a control to prevent the transfer of unwanted heat when the air-on condition rises above the required plant set-point.

9.74 In instances where the plant is cooling the air, it may be possible to remove heat from the supply air at high ambient conditions, under the dictates of enthalpy sensors in the intake and extract ducts.

Heater-batteries

General requirements

9.75 Fog coils are installed to protect the downstream filters from low temperature, high humidity intake air conditions. They should raise the incoming air temperature by 2 K so that it is above its dew-point when it arrives at the filter. As they handle unfiltered air they should be constructed of plain tubing without fins and be as near to the outside as possible to minimise condensation during cold weather. Access for cleaning should be provided to both sides of the coil. In order to prevent them freezing they should be controlled as constant flow variable temperature devices.

9.76 Traditionally frost coils were set to raise the incoming air temperature to between +2°C and +5°C to protect the batteries downstream. All new AHUs should be equipped with an energy-recovery device (see paragraph 9.65); the greater the temperature difference across this device, the more heat will be recovered. Also, the device will now provide the frost protection. Where an energy-recovery device is fitted, the frost coil will be replaced by a fog coil.

9.77 Where steam coils are used for a fog or frost coil, they may be constructed using spiral finned copper tube. As they will be prone to fouling, the tube layout and spacing should permit easy access for regular cleaning.

9.78 Main and branch heater-batteries should be constructed of solid drawn copper tube coils with copper fins, generally connected in parallel. In coastal and particularly exposed areas the client may require an anti-corrosion treatment.

9.79 Where there is a wet heating system in the areas served, the main heater-battery should be sized, in conjunction with the energy-recovery device, for the ventilation requirements only and not for the building fabric loss. Ventilation should only be used for heating the building fabric if the room specification precludes the use of heat emitters and it is not within the heated volume of the building (for example, a clean room or operating theatre with external walls).

9.80 Access for cleaning will be provided to both sides of all fog coils and heater-batteries.

9.81 Main heater-batteries may be water or steam. Electric heaters are expensive to operate, and their efficiency is particularly dependent on the air velocity through them. Their use should be restricted to branch trimming control.

9.82 Where steam supplied heater-batteries are used, their control, venting and trapping systems should be designed so that a vacuum cannot occur within the coil. The condensate drainage arrangements should not allow pressure to build in the condensate main as this will result in a back-up of condensate in the battery.

9.83 Where possible, wet trimmer heater-batteries should be located in plant areas.

9.84 Where it is necessary to locate heater-batteries in false ceilings etc, consideration should be given to the use of electric heaters (note that additional fire detection may be required). If this is not practicable and a LPHW system is used, a drip-tray should be installed under the control valve assembly to protect the ceiling. A moisture sensor and alarm should be fitted in the tray. In any event, to facilitate maintenance access, they should be located above corridors or other non-clinical areas and never above patient-occupied spaces.

9.85 Auxiliary fan coil units are not to be installed in the ceiling above a patient-occupied space. They should be accessible for routine maintenance and cleaning without the need to cause significant disruption to the operation of the area that they serve.

Cooling coils and drift eliminators

9.86 Cooling coils supplied with chilled water are the preferred option. For small loads, or where chilled water cannot be made available, direct expansion (DX) coils may be used.

Note:

For DX coils, it may be necessary to divide the chiller circuits unevenly in order to achieve efficient operation under part-load conditions. The turn-down ratio should allow stable control down to 10% of the peak load.

9.87 Cooling coils should be periodically decontaminated so the fin spacing needs to be ≥2.5 mm and the fins rigid enough to withstand cleaning (for example, ≥0.25 mm thick). Hinged access doors with viewing ports and illumination inside the AHU or duct should be provided both sides of the coil.

9.88 In an AHU when the cooling-coil face velocity is greater than 2 m/s a drift eliminator will be required downstream of the coil. The eliminator will be an entirely separate device mounted on slide rails so that it can be easily removed without the need for tools. If the size of the AHUs precludes the use of slide rails, and the eliminator is constructed in sections which maintenance personnel will have to enter

the unit to remove, each section should have lifting handles. In order to reduce the use of plastics, alternative materials should be considered for the eliminator elements.

Note:

For small DX coils and in fan coil units, the eliminator may take the form of a joggled extension of the fins.

9.89 All cooling coils are to be fitted with their own independent drainage system as specified in paragraph 9.105 onwards. A baffle or similar device should be provided in the drip-tray to prevent air bypassing the coil. The tray should be large enough to capture the moisture from the coil headers and drift eliminator.

9.90 Where coils are greater than 1.8 m high and the air velocity is >2 m/s, either intermediate drip-trays will be required or the fin spacing should be increased to ≥3 mm.

9.91 In order to minimise electrolytic action resulting from condensation on the air side, cooling coils constructed from copper tubes with copper fins and electro-tinned after manufacture are preferred. Aluminium fins should only be used if vinyl-coated.

9.92 All parts of the coil and its associated ductwork in contact with moisture will be manufactured from corrosion-resistant materials. Pressed steel coil headers, even if treated, have been shown to be prone to corrosion over time and should not be used. Steel mounting frames and casings present similar problems so stainless steel is preferred.

9.93 Where a cooling coil has to be located above a ceiling, a drip-tray should be installed under the battery and control valve assembly to protect the ceiling from leaks and condensation drips. A moisture sensor and alarm should be fitted in the tray. To facilitate maintenance access, they should be located above corridors or other non-clinical areas and never above patient-occupied spaces. The air velocity should be below 2 m/s to avoid the need for a drift eliminator. All drainage piping should be rigid type not flexible hose.

9.94 Auxiliary fan coil units should not be installed in the ceiling above an occupied space. They should be accessible for routine maintenance and cleaning without the need to cause significant disruption to the operation of the department that they serve. The drainage of such items is often problematic. If a suitable fall in the drain line cannot be achieved, a pump out system should be provided. Drainage piping should be rigid type (not flexible hose).

Humidifiers

9.95 Humidification was originally required for some healthcare applications in order to control the risk associated with the use of flammable anaesthetic gases. The use of such gases has now ceased. Humidification is therefore no longer required unless there is a very specific application requirement (see Chapter 8 and associated HBNs).

Note:

In an operating theatre, if high humidity is required to help prevent tissue drying during surgery, it should be provided when required using sterile water in a disposable nebuliser driven by medical air, and not from a humidifier installed in the ventilation system. In that way the quality of the moisture delivered will be assured.

9.96 If it is unclear at design stage whether humidification is required, provision for retrofitting in terms of space provision and a capped drainage system may be provided either in the AHU or in a zone branch duct. The need for such provision and the amount of space allowed

for it should be agreed in writing with the client.

9.97 If a humidifier is required, the manufacturer's instructions regarding selection, capacity, installation and control need to be followed. Incorrectly sized, installed or operated humidifiers can become a source of fungal and microbiological contamination within a ventilation system. This may result in a significant airborne infection risk to patients and staff.

9.98 Only steam injection manifold-type humidifiers are considered suitable for use in health building air-conditioning systems. The injected steam will be generated locally either by mains steam or electricity, within or adjacent to the humidifier. Water-curtain, water mist or spray humidifiers of any type cannot be used.

Note:

Jacketed lance mains steam humidifiers will always be a source of heat within the system during the cooling season unless completely isolated when not required.

9.99 All parts of the humidifier and its associated ductwork in contact with moisture should be manufactured from corrosion-resistant materials. Stainless steel is preferred.

9.100 For self- and locally-generated steam humidifiers, the cleanliness of the water supply is essential for their safe operation. The water supply should be derived from a wholesome source or demineralised supply. Chemical treatments cannot be added to the water supply to humidifier units. The electrodes of self-generating electrode boiler-type humidifiers should be stainless steel.

9.101 If the quality of the water supply to a self-generating humidifier unit cannot be assured, an ultraviolet (UV) system to control microbiological growth may be installed. However, given the limitations of UV systems, this will require high-quality water filtration to ensure the effectiveness of exposure of organisms to the UV irradiation. As with all water treatment systems the unit should be of proven efficacy and incorporate UV monitors so that any loss of transmission can be detected.

9.102 Provision should be made for draining down supply pipework and break tanks for periodic disinfection and cleaning during the seasons when they are not required in service. The humidifier branch water supply isolation valve will be located at the junction with the "running" main to prevent the creation of a dead leg. All parts of the system should be capable of being cleaned or disinfected as necessary. Hinged access doors with viewing ports and internal illumination should be provided. A label warning that the device emits live steam and should be isolated prior to opening should be affixed to the access door.

9.103 A zone humidifier, if required, may be installed in a supply branch. The ductwork in which the humidifier is mounted and for at least 1 m downstream should be stainless steel.

9.104 All humidifiers wherever installed will be fitted with their own independent drainage systems as detailed in paragraph 9.105 onwards and be completely accessible for cleaning.

Drainage

9.105 All items of plant wherever located that could produce moisture should be provided with a drainage system. The system will comprise a drip-tray, glass trap, air break and associated drainage pipework.

9.106 The drip-tray should be constructed of a corrosion-resistant material (stainless steel is preferred) and be so arranged that it will completely drain. To prevent "pooling", it is essential that the drain connection should not have an up-stand; and that a slope of approximately 1 in 20 in all directions should be incorporated into the drain outlet position.

9.107 In AHUs that have access doors large enough for a person to enter, the drip-tray should be easily accessible for inspection and cleaning.

9.108 In AHUs with access doors too small for a person to enter, the complete drip-tray should be capable of being withdrawn. It should be clamped into the AHU with thumb screws so that it can be removed without the need for tools (see photograph).

Removable AHU drainage tray

9.109 Each drip-tray should be provided with its own drain trap. The drain trap should be of the clear (borosilicate) glass type. This permits the colour of the water seal to be observed, thus giving an early indication of corrosion, biological activity or contamination within the duct. The trap should have a means for filling and incorporate couplings to facilitate removal for cleaning. It should be located in an easily visible position where it will not be subject to casual knocks. The pipework connecting the drainage tray to the trap should have a continuous fall of not less than 1 in 20.

9.110 Traps fitted to plant located outside or in unheated plantrooms need to be trace heated in winter. The trace heating should not raise the temperature of water in the trap above 5°C.

9.111 Water from each trap will discharge directly via a clear air gap of at least 15 mm above the unrestricted spill-over level of either an open tundish connected to a foul drainage stack via a second trap, or a floor gully (or channel). A support should be provided to ensure that the air gap cannot be reduced. More than one drain trap may discharge into the tundish providing each has its own air-break.

9.112 Drainage pipework from the tundish may be thermoplastic, copper or stainless steel. Glass should not be used. The pipework should be a minimum diameter of 22 mm and have a fall of at least 1 in 60 in the direction of flow. It should be well-supported and located so as not to inhibit access to the AHU.

Note:

In the case of fan coil units, the glass trap and air-break may be omitted and a pump out system fitted. The unit drainage should connect to the main drainage system via a waterless trap that does not allow discharged water to return. The drainage tray itself will be easily removable for routine inspection and cleaning.

Attenuators

9.113 Provided care is taken in the design and construction of low pressure systems to avoid significant noise generation in the ductwork, attenuation should only be needed to absorb fan noise.

9.114 Fans radiate noise through both the inlet and outlet connections, and it may be necessary to provide attenuation to limit the noise from both of these connections. It is always preferable and more economic to control noise and vibration at source, or as close to source as possible. It should be noted that attenuators offer a resistance to airflow and by causing turbulence can be the cause of regenerated noise in a system.

9.115 A thorough assessment of the design should be made to assess the potential noise problems. It should consider the following factors:

- fan and plant noise generation;
- airflow-generated noise in ductwork fittings and dampers;
- noise generated at grilles, diffusers and other terminals;
- noise break-in and break-out of ductwork;
- cross-talk and similar interference;
- the noise limitations for the building and surrounding areas;
- external noise generation.

A method of assessment of these factors and the sound attenuation requirements of ductwork systems is given in CIBSE Guide B.

Note:

Attenuators fitted in distribution ducts can themselves become a source of regenerative noise if the air velocity through them exceeds their tested performance value.

9.116 Attenuator units with a sound-absorbing in-fill suitable for the quality of air being handled and protected by a perforated sheet metal casing are the preferred option. Absorption of moisture, dirt and corrosive substances into the "in-fill" and the release of fibrous particles into the airstream should be prevented using a membrane with a declared service life of at least 25 years. If these conditions can be met, the attenuator may be located in the supply ductwork downstream of the final filter. Cleaning access should be provided at both ends of the unit.

9.117 Sound-absorbing material should not be applied to the inside surface of a duct.

9.118 End of line mixing and VAV boxes may be supplied lined internally with sound-absorbing material. The material will be non-particle-shedding, protected from casual damage during maintenance and be fire-resistant.

9.119 See paragraph 9.149 onwards for guidance on distribution and point of use noise control.

Note:

Developments in "dynamic attenuation" may replace the more traditional physical attenuators and overcome noise "break in" and point of use noise regeneration issues.

Recirculation – minimum fresh air requirement

9.120 Where return air is recirculated, fresh air should be introduced equivalent to at least 20% of the supply air volume, or that required by the Building Regulations, or at least 10L/s/person, whichever is greater.

Distribution system

9.121 The CIBSE guide B2 provides the standard design Information for ventilation systems, their ductwork and terminal devices. The guidance in this HTM highlights the specific factors that are required for or excluded from healthcare ventilation installations.

9.122 For normal applications in healthcare buildings, low velocity systems are recommended; velocities below 2 m/s are unlikely to be justified.

9.123 The site will often dictate the main routing of ductwork systems, as will the location of the AHU relative to the load. Grouping AHUs in centralised plantrooms results in large vertical service shafts and long main duct runs. Decentralising AHUs into service spaces adjacent to the load results in a more compact duct layout.

9.124 Whichever option is chosen, the design should seek to make the layout as symmetrical as possible; that is, the pressure loss in each branch should be as nearly equal as possible. This will aid balancing and may reduce the number and variety of duct fittings that are needed.

9.125 Main distribution ductwork should not be routed above sleeping areas. Where there is no alternative route, additional external acoustic insulation may be required.

9.126 Where auxiliary air-conditioning units, fans, filters or trimming devices are installed in the distribution system, they will be independently supported and fitted with a suitable drainage system where appropriate. If they are a source of vibration, they should be linked to the distribution ductwork via flexible connections.

Ductwork materials and construction

9.127 The choice of duct material should take account of the nature of the air or gas being conveyed and the environment in which the duct will be placed.

9.128 Galvanised sheet steel is suitable for normal ventilating and air-conditioning applications. Its inherent mechanical strength renders it resistant to casual damage both during the construction phase and throughout its service life when mechanical and electrical services around it are accessed. It may also readily withstand the impacts sustained when rotary equipment is used to clean it internally.

9.129 In instances where moisture levels and/or corrosive elements in the air being conveyed are very high, aluminium, stainless steel, PVC or GRP ducts should be used. Stainless or black steel are the only suitable materials for high temperature ductwork.

9.130 Where other ductwork materials are considered, care should be taken to ensure that the material is satisfactory for the application having regard to the likely service life, possibility of mechanical damage and performance in the event of a fire. Where used it will be installed strictly in accordance with its manufacturer's instructions.

9.131 Rectangular ducting with an aspect ratio of 1:1 is preferred but ratios of up to 3:1 are acceptable where there are space constraints. Circular spiral-wound or flat-oval are also acceptable providing they meet the leakage standard when tested (see Note after paragraph 9.136). Flexible ductwork is not suitable for air distribution in healthcare applications. In situations where solid ductwork cannot be used, flexible ductwork may be used to make the final connection to a terminal providing it does not exceed 0.5 m in length, is extended as far as possible and is never used in lieu of a bend (see paragraph 9.160).

9.132 The inside of the ductwork should be free from structural projections and as smooth as possible. Flanged gasketed joints between sections are preferred for rectangular ductwork, blind-riveted mastic-sealed slip-joints for circular and flat-oval.

9.133 In inherently wet areas, such as the base of fresh air inlet ducts and some extract systems, the ductwork may require draining to prevent a build-up of standing water. The layout of the drains should be as specified in paragraph 9.105 onwards.

9.134 Where builders' work plenum chambers or ducts are employed, all internal surfaces should have a smooth finish and be sealed to prevent dust shedding.

9.135 All types of ductwork should be manufactured and installed to the appropriate current BESA specification.

9.136 Ductwork should be supported with threaded rod and channel. Note that sheet metal ductwork cannot use bolt-through supports. Gripple wire may only be used for circular galvanised spiral-wound or flat-oval ductwork.

Note:

All installed ductwork whether new or reused should be subject to a leakage test on site prior to the application of any insulation. The leakage test will be to BESA DW144 but with a permissible leakage rate of not greater than 3%.

Fire aspects: damper types and locations

9.137 It is essential that all relevant fire aspects of ducting systems are agreed with the fire officer before the design is finalised (see paragraph 1.15 onwards).

9.138 Ductwork will be fire-stopped where it penetrates fire compartment walls, floors and enclosures, cavity barriers and subcompartment walls or enclosures, and provided with weatherproof collars where roofs or external walls are penetrated.

9.139 Fire and smoke dampers should be provided at the locations required by the Health Technical Memorandum 05 series of documents. The damper mounting frame should be securely attached to the building fabric strictly in accordance with the manufacturer's tested details. Where a fire and smoke damper is not mounted directly in a fire compartment wall, it must be correctly supported and the ductwork between it and the fire wall must possess the same fire rating as the fire wall that it penetrates. The fire-rated portion of ductwork must not be penetrated by test holes or inspection hatches (see also BESA DW145).

9.140 Any non-standard fire duct or damper arrangement should be agreed in writing by the client's fire advisor and subsequently tested and signed off by the installer.

9.141 An access hatch should be provided adjacent to each fire and smoke damper so that its correct operation can be directly observed. The hatch will be as large as necessary to permit inspection, testing and maintenance. The damper test switch should be mounted adjacent to the inspection hatch so that the routine test and visual confirmation of the damper operation can be carried out by a single person. For circular ductwork, rectangular saddle mounted hatches should be fitted (see BESA DW144).

9.142 Smoke-diverting dampers will be provided on recirculation air systems to automatically divert any smoke-contaminated return air to the outside of the building in the event of a fire. It should be arranged so that the normally open diverting damper in the return air branch to the input unit closes and all the return air is exhausted to outside (see paragraph 5.53 onwards).

Duct sections

9.143 When sizing ductwork, the designer should consult the CIBSE B2 guide.

9.144 All fittings should conform to the current BESA specification. Wherever possible, long radius bends, large radius main branches, not more than 45° angle sub-branches and long taper transformations should be used.

9.145 Bad design in relation to airflow can lead to vibration of flat duct surfaces, an increase in duct-generated noise, pressure loss in ductwork, unpredictable behaviour in branch fittings and terminals, and adverse effects on the performance of installed plant items, such as trimmer batteries.

Thermal insulation

9.146 In order to reduce energy consumption, achieve efficient energy recovery and prevent condensation in service voids, all supply and return air ductwork should be thermally insulated. Insulated ductwork runs outdoors should be weatherproofed.

9.147 The thermal insulation of intake and discharge ductwork will be dependent on its location in heated or unheated plant spaces and risk of surface condensation.

9.148 In normal circumstances, the insulation thickness for heat resistance is sufficient to prevent surface condensation, but in extreme conditions the insulation thickness for vapour resistance may be greater than that for heat resistance. When cold ducts pass through areas of high dew-point, carefully selected vapour barriers should be applied externally to the insulation.

Noise generation within the ductwork

9.149 Noise is generated in ductwork at sharp edges, by tie rods, damper blades, duct obstructions, sharp bends, etc. This airflow-generated noise becomes an important factor if it is about the same or greater level than the upstream noise level. Airflow-generated noise is often referred to as regenerated noise.

9.150 The noise level generated by airflow in ductwork is very sensitive to the velocity. The sound power of this noise is approximately proportional to the sixth power of the velocity; that is, a doubling of the duct velocity will increase the sound power by a factor of 64 (or about 18 dB). The duct velocities should therefore be kept as low as possible. In general, duct fittings which have lower pressure loss factors in similar flow conditions will generate less noise.

9.151 Ductwork serving quiet areas should not be routed through noisy areas, where noise break-in can occur and increase the noise level in the ductwork.

9.152 Grille register and louvre noise should be kept to the minimum by selecting types having low noise-producing characteristics, without high tonal noise; and should be fitted with acoustically treated external inlet and outlet louvres.

9.153 Cross-talk attenuators may be necessary where noise intrusion between adjacent spaces can arise and where individual room confidentiality is required. They will normally be of the "through-the-ceiling, up-and-over" type and may include a fire and smoke damper.

Volume control damper locations

9.154 In order to be able to carry out a full proportional balance, manually operated dampers are typically needed:

- in branches of zone ducts;
- in sub-branch ducts serving four or more terminals;
- in dedicated sub-branch ducts serving a room;
- at terminals not covered by any of the above.

9.155 Dampers integral with terminals are to be avoided for final trimming of air volumes, as they often create noise and air distribution problems.

9.156 Dampers in rectangular ducts should be opposed-blade multi-leaf type. In

circular ducts, iris-type dampers are recommended. Dampers should be accessible, incorporate a position indicator and means of locking in the commissioned position. They should be installed with the adjusting handle or knob at the lower vertical edge so that they are accessible for the commissioning team once the ceilings are in place. Dampers should be located as far away as possible from adjacent branches or plant items.

Duct cleaning and access door locations

9.157 Cleaning and access doors are required to facilitate access to plant items and ductwork components for inspection, maintenance, cleaning and replacement, and should be of sufficient size to permit safe access for the required functions.

9.158 Recommended locations for access doors are given in the current BESA TR/19 specification and are generally provided to give access to:

- every regulating damper;
- every fire-and-smoke, and motorised damper;
- filters (to facilitate filter withdrawal);
- both sides of trimmer cooling/heating coils;
- zone humidifiers;
- auxiliary fans;
- ducts, where required for cleaning.

9.159 Care should be taken when siting access doors to ensure that no other services to be installed will prevent reasonable access.

Flexible ducting

9.160 Flexible ductwork can only be used to make the final connection between rigid ductwork and a terminal in exceptional circumstances where a solid connection is not possible. Where used it will cause a significant frictional loss and may be difficult to clean, so it should take the most direct route and be as short as possible, never exceeding 0.5 m in length. It can never be used in lieu of a bend and will possess the same fire rating as the ductwork it is connected to.

Terminal fittings selection and sizing

9.161 The effectiveness of all ventilation and air-conditioning systems depends on the methods by which air is introduced to, and vitiated air is removed from, the space. The usual results of poor air-terminal selection and/or positioning are:

- draughts;
- stagnation;
- poor air quality;
- large temperature gradients;
- excessive noise.

9.162 Air can be supplied to a space in a number of ways, although any device can be broadly placed into one of two categories:

- that producing a diffused supply;
- that producing a perpendicular jet.

Diffusers may be radial or linear, and normally utilise the coanda effect (that is, adhesion of the air stream to an adjacent surface) to reduce the risk of excessive room air movement. A perpendicular jet is formed by discharging air through grilles, louvres or nozzles, which are generally adjustable.

9.163 Supply air terminals can be incorporated into any room surface, for example, floors, walls (high or low level), desktop.

9.164 As they operate on the jet principle, the use of sidewall and linear grilles is restricted to areas where air-change rates are low, that is, less than 10 per hour.

Perforated rectangular diffusers can provide acceptable conditions within the occupied zone at up to 15 ac/h. In areas where a higher air-change rate is required, square or circular ceiling-mounted diffusers should be used.

9.165 The performance of supply air terminal devices is based on three criteria – throw, spread and drop:

- Throw is defined as perpendicular or parallel distance from the terminal to the point at which the air velocity is 0.5 m/s isovel.
- Spread is defined as the width of the 0.5 m/s isovel.
- Drop is defined as the vertical distance from the centre line of the terminal to the bottom edge of the 0.25 m/s isovel.

9.166 It is necessary to consider each of these parameters in both summer and winter conditions to ensure satisfactory operation of the air terminal device, as warm jets behave very differently from cold jets.

9.167 A warm jet tends to rise until it attaches itself to a horizontal surface, while a cold jet falls. Care should be taken to ensure that this does not lead to unacceptable temperature gradients in winter, or excessive air velocities in the occupied zone in summer.

9.168 In order to ensure satisfactory air movement within a space, it is necessary to consider interaction between air movement from adjacent terminals, and ceiling-mounted fixtures (light fittings, etc), as well as interaction between air movement and room surfaces.

9.169 If the supply and extract terminals are too close, short-circuiting may occur, while if they are too far apart, stagnant zones may be formed. Where two opposing air streams meet, the individual velocities should not be greater than 0.25 m/s. Further guidance on the selection of grilles and diffusers is given in the CIBSE Guide B.

9.170 In operating theatres, the supply terminals should be able to produce a movement of air in the operating zone 1 m above floor level of between 0.2 and 0.3 m/s:

- Ceiling-mounted diffusers with fixed directional vanes that provide a downward turbulent airflow are the preferred option: 600 × 600 four-way blow or circular “air-master” style.
- Plenum boxes fitted with perforated screens to produce a laminar downflow are also acceptable.
- Linear ceiling-mounted diffusers that provide a downward-flowing air curtain around the operating theatre may also be used (additional supply terminals may be located within the area bounded by the linear diffusers to provide ventilation within the air-curtained zone).

9.171 The following terminal types are not suitable for use in operating theatres because they do not produce an appropriate pattern of air distribution:

- swirl diffusers;
- single- or multi-outlet adjustable directional nozzles or jets of any type;
- sidewall-mounted linear diffusers that utilise the coanda effect to send air across the ceiling and “droop” it into the operating zone.

9.172 Extract terminals should be of an easy-to-clean design and, in order to assist identification when commissioning and subsequently measuring, be of a different design style to the supply terminals. Extract terminals mounted at low level should be of the spring clip retained, pull off face type to enable ease of cleaning. The terminal should be mounted on an angled face to

prevent it becoming occluded by movable equipment or stores (see Appendix 9 for examples). Perforated plates are not to be fitted in extract terminals or extract plenums as they quickly become blocked with lint. Extract terminals do not need any directional adjustment so fixed-vane or "egg-crate" styles are preferred.

UCV terminal canopy

9.173 UCV canopies should be fitted with one or more non-electronic, mechanical, direct reading pressure gauge(s) to indicate the pressure drop across either a representative terminal EPA filter or the pressure in each zone of the canopy.

9.174 If a UCV canopy incorporates a method of adjusting the air discharge direction so that the canopy can be "tuned" to the room in which it is installed, the directional adjustment device(s) are to be capable of being locked in position once commissioning is complete to prevent future casual alteration.

9.175 Ceiling-mounted canopy diffusion screen(s) can become contaminated with blood spatter when in use. If the UCV canopy is fitted with perforated diffusion screens the blood spatter can penetrate, so the screens should be capable of being hinged down for cleaning between theatre cases. The screen retaining mechanism will have a double action to release the screen. Mono-filament diffusion screens should be retained by clip-in profiles or an alternative system that allows them to be easily removed when necessary.

9.176 For the validation of UCV terminal canopies, see Chapter 12.

Transfer grille: size and location

9.177 Air transfer grilles in walls, partitions or doors form an integral part of the building's air distribution system. Modern door sets have very low leakage rates so cannot be relied upon to permit even quite small airflows. Failure to make adequate provision for air to move from room to room will result in excessive pressure differentials and "door whistle".

9.178 Transfer grilles are required in locations where there is a significant imbalance between the supply and extract rates in a room. They will relieve any pressure differentials which may affect the operation of the spaces and/or the ventilation system and permit airflow in a known direction.

9.179 Care needs to be taken to ensure that the positioning of transfer grilles does not interfere with the fire or smoke integrity of the building. In general, the air transfer grilles should not be installed within fire-resisting boundaries, although if this is unavoidable, they should be fitted with fire or smoke dampers.

9.180 Where installed, transfer grilles should be of the non-vision type, sized for a maximum face velocity of 1.5 m/s.

Note:

Cross-talk attenuators may be necessary where noise intrusion between adjacent spaces can arise and where individual room confidentiality is required.

Pressure stabilisers: size and location

9.181 Pressure stabilisers are required in areas where it is necessary to maintain a pressure differential between adjacent rooms and to prevent reversal of airflows – for example, in operating suites, isolation facilities and clean rooms (see paragraph 8.24).

9.182 Fire precautions for pressure stabilisers are the same as for transfer grilles. If the pressure stabiliser is fitted with a fire and smoke damper, the damper test

switch should be easily accessible from, in airflow terms, the least clean side of the damper.

9.183 Pressure stabilisers should be of the balanced blade type, with the facility to make fine adjustment of the pressure setting. They should be silent in operation and give a seal as tight as practicable when closed. The materials of construction and method of assembly should allow for cleaning and disinfection.

9.184 Pressure stabilisers should be wall-mounted in a visible location so that their operation can be readily observed. For sizing criteria, refer to the manufacturer's information. When fitted at low level, they may require a stand-off cage to prevent occlusion (see photograph).

Pressure stabiliser with stand-off cage

9.185 Pressure stabilisers may need to be fitted with a stand-off baffle on their discharge side to prevent a sight line in situations where a laser will be used, and may be lead-lined for radiological protection if required (see photograph after paragraph 8.35). Baffles may also be needed to preserve privacy or prevent discharge air causing draughts within an anaesthetic room or bedroom. A stand-off baffle will always be needed on the theatre side of the pressure stabiliser between a "Lay-up" preparation room and a UCV theatre to prevent perturbation of the UCV canopy air pattern.

Note:

Baffles should be easy to clean and where radiological or laser protection is not required can be made of a rigid transparent material so that the action of the pressure stabiliser can be easily observed.

Distributed air-conditioning elements

Active and passive chilled beams

9.186 See paragraph 5.18 onwards for information on the use of these devices in healthcare premises and CIBSE Guide B for technical guidance.

Constant volume boxes

9.187 These are units fitted in or at the termination of ductwork that contain a mechanism to maintain a constant output air volume regardless of variation in the air pressure to the supply side of the unit. Where fitted they should be accessible for maintenance as the internal mechanism that controls the constant output will need periodic cleaning.

Variable Air Volume (VAV) boxes

9.188 Variable air volume systems are all-air systems which achieve local control by varying (throttling) the amount of air being supplied to each space, room or zone.

Standard type VAV systems deliver air that has been cooled to a set temperature (usually 13°C) and then control the temperature in a space by varying the quantity of air supplied rather than the supply air temperature – which is kept constant.

VAV boxes are used as terminal devices at the supply end of ductwork to modulate the quantity of supply air to the space.

There are variations to standard VAV systems which allow air supply temperatures to modulate upwards with the aim of:

- reducing energy usage by allowing higher air supply temperatures at part-load conditions;
- improving ventilation effectiveness at part-load by having higher airflows – VAV can be as low as 10% of peak at low-load conditions depending on the equipment used;
- allowing the system to operate using warm air in winter for pre-heating warm-up in well-insulated buildings where heating is only used in very cold weather and for building pre-heat.

9.189 In most critical areas of a hospital a fixed air-change rate is required when they are in use. VAV is therefore generally limited to non-clinical applications.

Stand-alone air-conditioners

9.190 See paragraph 5.25 onwards for information on these units. The ceiling void should never be used as a plenum either for the primary air supply or fan coil supply or return air paths. (See CIBSE Guide B for installation notes.)

Powered air terminal filter units

9.191 This is an air-distribution-supply terminal box fitted with a fan and EPA or HEPA filter. Their use in the healthcare setting would be confined to spaces where a high air quality is required for a single room in an area supplied by a general AHU (for example, a local clean room).

9.192 They are not suitable for use in patient bedrooms due to the fan noise and maintenance access issues.

AHUs: automatic control

9.193 Chapter 6 of this document gives guidance on energy control strategies and Chapter 7 gives guidance on the point of use factors. Chapter 8 contains guidance to specific healthcare departments and their environmental and functional requirements. This section gives guidance on the control of the AHU and its subsystems. When developing a "controls specification", the designer should consider the guidance given in all of these chapters.

9.194 Various options for control of single- and multi-zone air-conditioning systems are given in CIBSE Guide B.

General requirements

9.195 The basic requirements for an automatic control system are as follows:

- plant start, run, set-back and stop sequence;
- control of the volumetric airflow;
- control of the system or room pressure;
- temperature control and indication;
- humidity control and indication;
- devices to monitor and indicate the plant's operating state;
- alarms to indicate plant failure, low airflow, and filter state;
- the facility to collect data of actual usage and energy consumption.

The control functions actually provided will depend on the purpose of the ventilation system.

9.196 The designer should consider whether it is necessary for the supply and extract fans to be interlocked, either so that the supply fan will not operate unless airflow is established within the extract system, or vice-versa depending on the required pressures within the rooms being served.

9.197 The sequence switching of units in order to prevent transient reverse airflows will be particularly important in laboratory and pharmacy areas that also contain fume cupboards, safety cabinets and other LEV systems.

9.198 There will also be a need to determine the control strategy in the event of a fire either within the zone being served or within an adjoining zone and as detailed in the fire alarm cause and effect statement (see paragraph 7.16 onwards).

9.199 All supply AHUs should have a smoke sensor linked to the fire control panel and mounted in the main supply duct immediately downstream of the AHU. In the event of a fire in the AHU or smoke being drawn into the system from an outside source, it should cause the supply air fire damper to close and shut down the AHU.

Note:

In certain critical departments, it is preferable to maintain the ventilation in the case of a fire within the area. For example, in an operating department while undergoing surgery the patient cannot always be easily moved without significant risk. In the event of a fire in a staff or support area of the department or adjoining zone, the continued supply of air to a theatre will maintain it at a positive pressure and protect the patient and staff from the effects of smoke.

This will allow time for the patient to be stabilised so that they can be safely evacuated if necessary. A similar situation occurs for patients in critical care areas and other units where a certain amount of preparation is required before patients can be safely moved. In all of these cases the ventilation to the critical area should continue to operate unless the AHU starts to draw in smoke. For these departments, a notice should be affixed to the fire control panel drawing attention for the need to liaise with departmental staff before switching off fan units.

Location of controls

9.200 Facilities to start, set-back and stop the plant should be provided in the plantroom. Remote start and set-back control and indication, if required, should be provided at a manned staff location, for example, at the reception or staff base.

9.201 Many ventilation systems may be completely shut down when the area served is not in active use. Alternatively, where there is a need to maintain a background condition, the ventilation output may be reduced by "setting back" the system. This will significantly reduce energy consumption and extend the life of filters and other system components. Controls to facilitate this should be triggered by the actual occupancy of the area rather than by a fixed time program (see paragraph 6.2 and associated Note).

Start up and shut down control sequence

9.202 The AHU should start and shut down in a pre-determined sequence. It should ensure that the fan does not start until the main dampers are open and the energy-recovery device is operational. On shut down there may be a need for a "run on" time to purge the area served before stopping the fan and closing the main

dampers. Whether the supply or extract fan should start first and stop last will be determined by the pressure regime for the area served.

Set-back control

9.203 In previous times when fan motors only had two speeds, turning the system to "Set back" meant switching to the lower fan speed. With modern fans the speed is widely variable so "Set back" is not a fixed fan speed but rather a control strategy that reduces the system output in order to maintain a desired minimum condition. This may be related to the air velocity at a fixed point, air-change rate, pressure differential, temperature, humidity or a combination of these parameters. Providing a dew-point sensor in an internal space that brings the system onto "Set back" is a simple way of maintaining a minimum condition.

AHU running controls

Fog/frost coil control

9.204 Fog coils supplied by low pressure hot water (LPHW) should be controlled using the Proportional mode. Their sensor should be located downstream of the coil to give "closed loop" control. The coil should raise the incoming air temperature by 2 K in order to ensure that air entering the pre-filter is above its dew-point, thus keeping it dry. The greater the energy put into the incoming air by the fog coil, the lower will be the efficiency of the energy-recovery device.

9.205 If the temperature downstream of the fog coil, as sensed by a serpentine thermostat, falls below the required set point over any part of the coil, the plant should automatically shut down in order to prevent damage to the other batteries. The serpentine thermostat cannot be in direct contact with the coil and should cover the entire coil face.

9.206 Steam-supplied fog or frost coils should be operated as an on/off device to ensure that there is no standing condensate at the base of the coil. They should be fitted with a serpentine sensor mounted upstream of the coil but not in contact with it. This will give "open loop" control; a set point of +1°C is recommended.

Energy-recovery device

9.207 The energy-recovery device is normally controlled by sensors in the air intake downstream of the supply fan, before the cooling coil and the extract duct from the ventilated space.

Supply & extract fans

9.208 The ErP Directive 1253/2014 requires a means of adjusting the fan speed. For plug fans this is provided by a separate inverter unit; for EC fans the control is integral to the fan motor. It should be remembered that most healthcare applications require known amounts of air to be delivered while the system is in use. Constant volume systems that deliver specified air-change rates are therefore the norm. Duct- or room-pressure-controlled variable-volume systems have a limited application in healthcare. However, fan-speed control is beneficial when "setting back" the system.

9.209 Inverters should not be mounted inside the air stream within the AHU. Ideally, they will be mounted on a frame with the control valves. Where inverters are mounted inside a control box with a safety master switch to cut the power supply when the box is opened, the inverter control and indicator pad will be located on the outside of the box. This will allow on-site staff to view the operating parameters and switch the system to manual control if a fault occurs with the automatic control system.

9.210 It is necessary to ensure that should the computer control system or its software develop a fault, the fan can be switched to

manual operation. This is particularly important for critical systems serving operating suites, high dependency care units of any type, patient isolation facilities, laboratories and pharmaceutical production suites.

Note:

In the healthcare setting it is important to recognise that "off-site" software support is no substitute for the ability of "on-site" staff to override the automatic control and keep the system operating in an emergency. Under these circumstances actions that may shorten the life of the plant are considered of secondary importance to that of preserving the health and safety of patients and staff.

Heater-batteries

9.211 The main heater-battery should be controlled in the same manner under the dictates of an off-coil temperature sensor, or a room temperature sensor, or the return air temperature depending on the plant configuration and method of control. Trimmer heater-batteries are generally controlled by a temperature sensor within the room, or by averaging temperature sensors within a zone.

9.212 Heater-battery control valves should drive closed on system shutdown or fan failure. The control system should then automatically set to provide frost protection.

Cooling coils

9.213 There are two basic methods of control for cooling coils:

a. off-coil control – used in multi-zone systems or single-zone systems where close humidity control is required, to provide a constant maximum off-plant condition which satisfies the temperature and humidity requirements of the zone with the highest load;

b. sequential control – used in single-zone systems, or multi-zone systems with averaging sensors where close control is not required. A room or duct temperature sensor controls the cooling coil and heater-battery in sequence to maintain constant room conditions.

9.214 The advantage of off-coil control is that accurate humidity control can be provided without relying on humidity sensors, which are prone to inaccuracy and drift. Off-coil control is expensive to operate in terms of energy consumption because of the lack of feedback of room loads. As a result, at low loads and in systems where there are large zonal variations, significant over-cooling and reheating will occur.

9.215 The control logic should prevent the cooling coil and heat recovery and/or heater-battery being on at the same time.

Humidifier control

9.216 Accurate humidity control can only be provided on single-zone systems, or multi-zone systems with zonal humidifiers. In the above systems, humidity sensors control the humidifier for low-level humidity control, and override the temperature controls to open the cooling-coil valve for high-level humidity control.

9.217 Multi-zone systems are more usually controlled by a minimum humidity sensor located in the supply duct(s) following the last heater-battery.

9.218 Overriding controls separate from the normal plant humidistat should be installed. Their purpose is to prevent excessive condensation in the conditioned space when starting up. A time delay should be incorporated into the humidifier control system such that the humidifier does not

start until 30 minutes after the ventilation/plant start-up. In addition, a high limit humidistat should be installed to limit the output of the humidifier so that the saturation in the duct does not exceed 70%. This humidistat is to control the added moisture; it is not necessary to install a dehumidifier to reduce the humidity of the incoming air if it already exceeds 70% (part load control).

9.219 The humidifier control valve should close when the ventilation system is in "set back". In addition, on system shutdown, low airflow or fan failure, the humidifier should be isolated.

9.220 In a self-generating humidifier, if the humidifier is unused for a period exceeding 48 hours, it should automatically drain its water content, including that contained in the supply pipework, right back to the running main and leave itself empty.

9.221 With certain types of steam humidifier, it may be necessary to install a thermostat in the condensate line from the humidifier's steam supply, to ensure that the steam at the control valve is as dry as possible before it is injected into the air supply.

9.222 The humidifier control system should ensure that it is switched off with the fan. It is preferable to design the control system so that the humidifier is isolated for an adequate time before the fan is turned off to purge humid air from the system.

Control valves: general

9.223 The fog/frost battery control valve should fail-safe, that is open in the event of power or airflow failure. All other valves will stop in their current position in the event of power failure and should drive closed in the event of airflow failure.

9.224 Control valves should be located in an accessible position. Isolation valves should be provided to enable the control valve to be removed for service or replacement without the need to drain down the system.

9.225 Care should be taken to ensure that the installation of control valves and their associated pipework do not obstruct access to the AHU inspection doors, removable drainage trays, eliminator units and access hatches.

Note:

There are practical advantages in locating all control valves for an AHU in a bank (at a convenient height) at one end of the unit. (This should not result in an additional control lag.) The bank will hold the control valves and actuators, and fan inverters/controllers as necessary, and can be constructed "off site" (see also paragraph 9.209).

Monitoring and alarms

9.226 Monitoring of the plant performance should be via a BMS to the estates and maintenance department.

9.227 The "plant failure" and "low airflow" alarm should be initiated by a sensor located in the main air supply duct. This should operate when the air quantity fails to reach or falls to around 80% of the design value and will give indication of fan failure, damper closed, access door left open, or any other eventuality that could cause a reduction of air quantity. Monitoring the current drawn by the fan motor is not a substitute for a sensing device that is directly affected by the airflow. The sensing ring fitted to plug and EC fans will fulfil this function.

9.228 The "filter fault alarm" should be initiated by a predetermined increase of pressure differential across the filters, thereby indicating a dirty filter. The filter fault indication and alarm is information for the maintenance department; it should not

appear on any point of use indicator or control panel.

9.229 Visual indication that the AHU is operating within its prescribed parameters should be provided in critical areas at a manned staff location, for example, the reception or staff base. These need only take the form of a green light to show the system is operational and a red light to show that it is not.

Room temperature control

9.230 The limits for room temperature set point are generally between 18°C and 25°C depending on the particular application, and in some specialised instances (for example, operating departments) are adjustable within a predetermined range by the user.

9.231 The selection of temperature set point for each room or zone may be by a control facility in the room/zone, or remotely at the control panel or BMS. Where the control device is mounted within the room/zone and adjustable by the user, it should be marked either "raise" and "lower" or "+" and "–". It should control within a specified temperature range to suit the user requirement with a control tolerance of +1 K. All other control set points should be selectable either on the control panel or at the BMS interface.

9.232 Where local control is provided, an indication of temperature will be required locally, or at a staff base (if appropriate), using an analogue or digital indicator. The indicator should be large enough to be read from the normal working position (for example, at the operating table in a theatre). This may be mounted in a supervisory control panel, with the signal repeated on the main system control panel or BMS. It is important that this indicator displays the actual measured temperature and not the selected temperature.

Local exhaust ventilation (LEV)

9.233 Devices that use an inflow of air to control exposure of staff to hazardous substances are classified as LEV systems under the COSHH Regulations.

9.234 An LEV system will typically comprise a unit where the airborne hazard is captured, ductwork to convey the extract air to the fan and a discharge stack. The extract air may be filtered or centrifugally separated to remove any particulate material prior to discharge. HSG 258 produced by the Health & Safety Executive gives detailed guidance.

9.235 It is important to recognise at the design stage whether an extract is being provided for comfort, to remove odours or to remove hazards, in which case it will be an LEV system. Chapter 8 lists typical devices used in healthcare applications.

9.236 The quantity and location of the terminals supplying the make-up air is an important factor in the design of LEV systems.

9.237 LEV systems are statutory items that will be subject to an independent examination and test at least every 14 months by a competent person.

Extract ductwork and fan

9.238 Extract ductwork for an LEV system should, where possible, be installed outside of a building. Where it has to be inside, it should take the most direct route through, with as few bends or changes of direction as possible.

9.239 All ductwork joints should be sealed and ideally there should be no access hatches. Where access hatches have to be provided, they should be of a type that has a hermetic seal.

9.240 Some substances are particularly corrosive, so the choice of material for the ductwork, and type of extract fan fitted, should reflect the nature of the substance being conveyed.

9.241 The ductwork should either be fire rated or fitted with intumescent collars where it passes through fire compartments within the building. This will ensure that the extract system is unobstructed and always open to atmosphere up to the discharge point.

9.242 Some LEV systems (for example, microbiological safety cabinets) HEPA-filter the extract air within the cabinet unit, but it should not be assumed that the exhaust air will be totally free from microbiological or other hazardous material.

9.243 The extract ductwork should as far as practicable be kept under negative pressure while inside the building. The extract fan should be located outside of the building or if this is not practicable, as close as possible to the outside so that any ductwork on the discharge side inside the building is kept to an absolute minimum.

9.244 The extract fan drive motor should be out of the airstream and it should be possible to change the motor without disturbing the fan or its casing.

9.245 Duplex fans are only required when several LEV systems share a common extract system (for example, multiple fume cupboards in a large pathology department where it can be anticipated that at least one cupboard will always be in use or need to be available for use). In such a situation each cupboard should be fitted with a non-return damper at the point that it joins the common system and be capable of being isolated from the common extract system. The common extract duct should be large enough to handle the combined extract volume from all the systems that feed into it.

9.246 If extract filters are fitted in the ductwork the system design should allow them to be changed safely.

9.247 Current standards permit the installation of microbiological safety cabinets with integral fans, provided that the extract ductwork can be kept short (that is, less than 2 m); such an installation, however, is likely to be noisy and is not recommended for use in new buildings.

LEV discharge stack arrangements

9.248 Roof-level discharge, wherever practicable, is preferred since it removes much of the uncertainty over air re-entering the building through ventilation inlets or windows. In such an installation, the extract fan should be situated separate from the LEV captor unit and close to the discharge stack to maintain the duct within the building under negative pressure.

9.249 The discharge point on a flat roof should be through a terminal at least 3 m above roof level. This will protect those who may need to access the roof. Terminals at other roof types need to be high enough to prevent the wind blowing across the roof from causing downdrafts.

9.250 Where there are adjacent buildings with opening windows, or where downdraughts are likely to occur, it may be necessary to increase the height of the discharge stack in order to achieve adequate dispersal. In complex locations, airflow modelling or wind tunnel tests may be required to determine the optimum height

9.251 The discharge stack should have an open end. It may be fitted with a collar to reduce its area and so increase the air efflux velocity at the point of discharge (known as the venturi effect). To ensure that air leaving the terminal is not deflected down but allowed to disperse freely, the terminal cannot be fitted with any sort of cover or

hat. A drain may be required at the base of the discharge stack to remove any rain that enters (see photograph).

Typical LEV discharge stacks

LEV system information and identification

9.252 Once installed, all elements of each LEV system should be uniquely identified with a permanent label as described in Chapter 13.

9.253 There is a statutory requirement to have information on the design and required operational performance of an LEV system available to those who are responsible for its operation and maintenance. The designer should ensure that this information is available at handover.

10.0 Installation standards

General

10.1 AHUs, ductwork sections and associated elements of the ventilation system will be delivered to site suitably packaged to protect them from damage and casual contamination. They should remain protected when stored on site awaiting installation.

10.2 Ductwork should be installed to the "Advanced Level" as defined in BESA's (2019) 'TR/19: Guide to good practice – internal cleanliness of ventilation systems'. Should any doubt exist as to whether the guidance has been observed, the ducts should be cleaned internally to restore them to this standard and be visibly clean before being taken into use.

10.3 When the ventilation elements are installed, all open ends have to be sealed to prevent the ingress of construction dust as installation progresses. The access doors and panels of AHUs should be kept closed. All AHU dampers and fire dampers should be covered to prevent casual contamination during the construction phase. This is particularly important for fire dampers mounted in the plantroom floor. The damper blades should be wiped clean before final connection to the distribution ductwork.

10.4 The area around the supply air intake should be kept free of vegetation, waste, rubbish, builders' debris or any other possible source of contamination.

10.5 "Builders' work" ducts of brick or concrete should have a smooth internal finish and be surface sealed to prevent the release of dust before being taken into use. They should be fitted with a drainage system if not self-draining.

10.6 Every effort should be made to prevent the internal contamination of the ventilation system during the construction phase as once contaminated, it is extremely difficult to completely remove dust and debris. In particular, extract and recirculation fans should not be run up until the area is at least "builders clean" – that is, the floors swept and wet-mopped – otherwise the energy-recovery device in the AHU could become contaminated and its efficiency significantly reduced.

AHUs

10.7 Units should have a working life of up to 20 years; it can be anticipated that over this period there will be a need to access every element within the unit for deep cleaning. It is also quite possible that during the life of the unit, the main fan and all control valves will need replacement. Heater and cooling coils may also need to be repaired or replaced. Suitably positioned service connection joints and adequate

spacing should permit these items to be isolated and withdrawn without the need to drain down entire systems or dismantle other installed plant.

10.8 Care should be taken during installation to ensure that electrical and mechanical services are not installed in positions that will reduce or impede access. Mounting all control valves and fan controllers on a frame positioned adjacent to the unit is the preferred option. This approach has the advantage that the frame and its components can be built and tested "off-site".

10.9 In order to reduce the effects of galvanic corrosion, black iron fittings should not be used in the pipework installation. Rolled jointed stainless-steel pipework is preferred.

10.10 Vibration from a remote plantroom can be transmitted by the structure of the building, and may be regenerated and sometimes magnified many times. Pipe and ductwork should incorporate anti-vibration couplings, pipe hangers and supports, preferably in two planes at right angles, as close to the vibration source as possible.

10.11 The service connection points for pipework and electrical conduits will have been made during construction of the unit. The unit will then have been leak-tested in the factory prior to delivery to site. If there is a need to drill through the AHU casing or panels (for example, to mount a sensor), the hole should be as small as practicable and sealed to prevent air leakage.

10.12 It is essential that the AHU/ductwork is mounted far enough from the floor to permit the correct installation of drainage systems for cooling coils, humidifiers and heat recovery systems. If the AHU is located on a roof, it will require a clearance of 600 mm to provide access to maintain the building structure below. Sufficient height for the installation of drainage pipework and traps should always be allowed. Easy access for maintenance of drainage systems and their associated pipework should be provided. It should be possible to fully withdraw the drainage tray if it is of the removable type.

10.13 AHUs should be positioned so that all parts are easily and safely accessible for routine inspection and service. If a unit is located against a wall or backs onto another unit, access to all parts should be available from the front. Units greater than 1 m wide should preferably have access from both sides or access doors large enough to permit the full and safe entry of maintenance personnel.

10.14 Air filters, cooling-coil drainage trays and drift eliminators are all items that should be changed, inspected or withdrawn on a regular basis. The installation of the AHU should permit this without the need for tools or to dismantle other plant or systems.

10.15 Access to air intakes and discharges, AHUs and items in the distribution system such as filters or auxiliary trimmer batteries located in a plantroom or plant area should be via fixed ladders, hook ladders, pulpit style steps or other moveable access platforms. The installation of distribution ductwork and other electrical or mechanical services should provide sufficient clearance to allow access equipment to be moved into position.

Distribution systems

10.16 Where ductwork penetrates a roof, it should be protected by an upstand to prevent water penetration. Where it penetrates an outside wall, the method of installation should prevent water tracking along the ductwork into the building or its wall cavity.

10.17 The installation of all services in service ducts and above ceilings should be

coordinated so that cable trays, medical gas and other pipework do not obstruct or prevent access to the ductwork cleaning doors, dampers and any auxiliary plant elements. The use of BIM should highlight clashes at the design stage.

10.18 Plant elements such as VAV boxes, trimmer heaters or cooling coils, humidifier lances or branch filters that are located outside of plant spaces should be accessible for routine inspection and have a cleaning access door on both sides. They cannot be installed above any of the following areas:

- operating theatres;
- preparation rooms or sterile pack stores;
- anaesthetic rooms or recovery areas;
- rooms containing imaging equipment;
- pharmacy clean rooms;
- containment laboratories;
- patient bedrooms and isolation rooms.

10.19 Rectangular ductwork sections should be joined by bolted or clipped gasketed flanges. Circular and flat-oval slip-joints should be mastic-sealed and held with blind rivets, not screws. The mastic used should not support biological growth. The ductwork installation will be leak-tested prior to acceptance.

10.20 Volume control dampers (VCD) should be oriented so that their adjusting handles or knobs are located at the lower vertical edge or bottom of the damper when mounted above ceilings. The means of adjusting the damper will be within sight and reach from a designated ceiling void access hatch once the ceiling is complete. Volume control dampers mounted in any location should have the control adjuster mounted to allow easy access for the commissioning team and for future access when a post-cleaning rebalance is undertaken.

10.21 Access to VCDs or local auxiliary fans mounted above ceilings should be via low-leakage access hatches mounted in the ceiling or hatches integral to a light fitting.

Note:

Obtaining access by removing a light fitting is not acceptable.

10.22 Where ducts are drilled to provide test holes or to mount sensors, the swarf should be removed, and the hole deburred before the fan is started.

Note:

Care should be taken to prevent the inadvertent drilling of attenuators.

10.23 Flexible ductwork may only be used if there is no other way of connecting an air terminal to a duct. The flexible duct should be not more than 0.5 m in length, be as fully extended as possible and never used in lieu of a bend. The fire rating of the flexible duct should be no less than that of the fixed duct that it is connected to (see also paragraphs 9.131 and 9.160).

10.24 Fire and smoke dampers must be installed strictly in accordance with their manufacturer's instructions. There will be a rectangular access hatch (saddle mounted for circular ducts) and test switch adjacent to the damper so that a single person can trigger the damper and directly observe its operation during the annual test (see photograph). When pressure stabilisers incorporate a fire damper, the test switch is to be located in an easily accessible position on the less clean side of the pressure stabiliser.

Fire damper with test switch and inspection hatch

Point of use

10.25 Items of equipment that require access for inspection and cleaning should not be accepted if they are installed in locations that prevent easy access.

10.26 Items of equipment that require access for inspection and cleaning such as fan coil units will not be accepted if they are installed directly above medical or diagnostic equipment.

Note:

A common problem occurs because installation layout drawings show fan coil or similar units on the room plan. These are often only "indicative" of the fact that there will be a unit in the room but are taken as the desired position by those carrying out the installation. As an example, the installation drawing for an interventional imaging room shows a fan coil unit in the centre of the ceiling. If it is installed in this position it will be directly above the scanner once that is installed. The fan coil unit will then not be accessible for routine inspection and maintenance, and should it leak water, it will put the scanner out of action.

10.27 The installed position of ceiling terminals in storerooms (for example, a theatre's bulk sterile pack store) should coordinate with the siting of the storage racking. The airflow at the terminals should be routinely measured, so the racking and its contents should not obstruct access to the terminal when using a calibrated hood. The same problem can occur in recovery rooms and ward areas where bed curtain rails and bed hoist tracks can prevent the measurement of airflow from ceiling terminals.

10.28 Low-level extract grilles should be of the pull off face type for ease of cleaning.

10.29 See pictures of low level extract installations in Appendix 9.

Service penetrations

10.30 Where services penetrate the fabric of the building, they should be sealed to prevent any uncontrolled air leakage between rooms and service spaces or voids. Situations where this occurs will be:

- service spaces behind IPS panels at wash basins and scrub troughs;
- cased in wall-mounted medical gas pipeline units and ceiling-mounted pendants;
- electrical trunking and bedhead rail systems;

- boxed-in main and local drainage pipework;
- ceiling-mounted operating lights, examination lights and other pendant-supported items.

The sealing should be at the point that the service penetrates the wall, ceiling or floor and not at the access panels or covering shrouds as these will need to be removed from time to time. Sealing of the penetrations should be done at first-fix stage as access will become progressively more difficult once final covers and finishes are applied. In certain applications, permeability testing will be carried out at first-fix stage to ensure that this has been done.

Floor marking

10.31 In UCV theatres the entire "clean zone" under the UCV canopy will be designated by a contrasting colour of flooring material. A line marked on or cut into the floor covering is not sufficient.

Note:

The "clean zone" is not the same as the overall size of the canopy, and it is vital to consult the UCV canopy supplier in order to get the position and size of the zone correct, as mistakes are expensive to rectify.

11.0 Commissioning systems

General

11.1 Commissioning is the process of advancing a system from physical completion to an operating condition. It will normally be carried out by specialist commissioning contractors working in conjunction with equipment installers. Commissioning of the ventilation system will normally be the responsibility of the main or mechanical contractor who should coordinate the process.

11.2 Commissioning is often subdivided into sections (for example, air handling unit, automatic controls, air side balance, building fabric and fittings). Each section may be commissioned by its specialist installer, and they are often accepted in isolation.

11.3 Commissioning is an essential process for ventilation systems. It is therefore important that adequate provision for the process be made at the design stage of the project. Procedures for commissioning air-handling systems are given in CIBSE Commissioning Codes and BSRIA BG 49 – Commissioning Air Systems.

11.4 The duct design process should take into account the requirements of system balancing. The position and number of regulating dampers included in the design should be sufficient for this purpose.

Location of dampers and test holes

11.5 Balancing/commissioning dampers will be required in each branch of the distribution ductwork. In a critical system such as an operating suite, the branch to each room and each location where it is required to carry out a proportional balance should have a balancing damper.

11.6 Test holes for the measurement of airflow will be required at carefully selected points in main and all branch ducts. The number and spacing of holes are given in the BSRIA BG 49/2015 Commissioning Air Systems. Their positions should be identified at the design stage.

11.7 The test positions need to be accessible for commissioning to take place. They may also be required for subsequent annual verification of the system performance, so they should not be covered by permanent lagging.

11.8 The measurement point should be in a straight length of duct as far away as possible from any upstream bends, dampers or other elements that could cause disturbance to the airflow. The actual location should be:

- at least 1.5 duct diameters upstream of sources of turbulence such as dampers and bends;

- if this is not possible, ten diameters downstream of dampers, bends or tees, and five diameters downstream of eccentric reducers;
- where there is enough space round the duct to insert the pitot tube and take readings;
- where the duct has a constant cross-sectional area.

Test holes for measuring total airflow from a fan should be located either four diameters upstream or ten diameters downstream of the fan. Provision should also be made for measuring the fan's speed of rotation.

Note:

Plug and EC fans are supplied with a measuring ring so their output can be read directly. This needs to be connected to an external pressure tapping or electronic fan control unit.

Information to be provided

11.9 It is essential that the designer should pass on the system-design intent fully to the commissioning engineer by providing:

- relevant parts of the specification;
- schematic drawings indicating data listed in Table 11;
- equipment schedules;
- controller and regulator schedule;
- fan performance curves;
- wiring diagrams for electrical equipment, including interlock details.

Table 11 Information to be provided on schematic drawings

Items in system	Information to be provided
Fans	Fan total pressure Volume flow rate at normal and set back speed Maximum motor current
Plant items	Type and identification numbers from equipment schedules Fluid and air volume flow rates Fluid and air side pressure losses Dry bulb temperatures Wet bulb temperatures Humidity
Dampers, including motorised and fire dampers	Identification numbers from equipment schedules Location Identification number Volume flow rate
Main and branch ducts	Dimensions Volume flow rates and velocities Identification numbers from equipment schedules
Test holes and access panels	Location and size of duct Identification number Design airflow rate
Room supply and extract terminals	Location Identification number Grille or diffuser factor Volume flow rate and neck velocity Operating static pressure
Pressure cascade	Room differential pressures Airflow direction between rooms Pressure stabiliser and transfer grille locations
Internal environment conditions	Design room conditions and adjustable range Specific room air velocity if specified Noise level
Controllers	Set points

Notes:

1. Fan total pressure is the difference between the total pressure (static pressure + velocity pressure) at the fan outlet and the total pressure at the fan inlet.
2. Where volume flow rates are variable, maximum and minimum values should be provided.

Commissioning personnel

11.10 It is unlikely that all the required commissioning skills will be possessed by one individual; a commissioning team is therefore usually needed. The objective of commissioning is to ensure that the necessary performance and safety requirements are met.

11.11 During the commissioning process a great deal of information will be generated which will form an invaluable future source of reference about the plant. It is essential to ensure that it is collected together in the form of a commissioning manual and handed over to the client on completion of the contract together with the "as fitted" drawings.

11.12 In order to be successful the commissioning process will need to start before practical completion, as many parts of the system will become progressively less accessible. The correct installation of those parts should be witnessed and leak rate tests carried out as construction proceeds. Failure to establish responsibility for commissioning early enough will delay the completion of the project or lead to unsatisfactory plant performance (see CIBSE Commissioning Code M).

Commissioning brief

11.13 The commissioning team will require a detailed brief from the system designer. This should include:

- a "user" brief comprising a description of the installation and its intended mode of operation;
- the precise design requirements with regard to the scheme of air movement, room static pressures, supply and extract airflow rates and acceptable tolerances;
- full details of the design conditions both inside and out, for winter and summer, together with the control strategy;
- equipment manufacturers' type test data, commissioning, operation and maintenance recommendations;
- drawings showing the layout of the system, positions of airflow measurement test points, dampers, regulating devices and filters within the duct runs, together with sizes of ducts and terminal fittings. It will save time if these drawings are annotated with the design volumes and static pressures required at each branch and outlet point;
- wiring diagrams for all electrical equipment associated with the air-handling systems, including motor control circuit details and any interlocking and safety devices.

11.14 CIBSE Commissioning Code A – 'Air distribution' or BSRIA BG 49 – 'Commissioning air systems' provide full guidance on the information that will be required by the commissioning team.

11.15 Designers should specify the type of measuring instruments and test procedures. They should include in the contract documents instructions on verifying the accuracy of test instruments, which should be supported by reference to relevant calibration certificates.

11.16 The system, on completion, should be operated by the contractor as a whole and subject to performance tests in accordance with the contract requirements. These will include independent validation of the system performance on behalf of the client.

11.17 The commissioning process should be carried out in the order in which it appears in this guidance document. That is to say, the static checks and visual inspections itemised in paragraphs 11.20–11.26 should be followed by the dynamic tests described

in paragraphs 11.27–11.46, the performance tests listed in paragraphs 11.47–11.64 and finally the handover procedures set out in paragraphs 11.63–11.65.

11.18 Once the system is shown to meet the design intent, the handover documentation should be completed. In the event of performance not being acceptable, the matter should be dealt with in accordance with the contract arrangements.

Pre-commissioning checks

11.19 The pre-commissioning checks consist of visual inspection, manual operation of equipment, static measurements and functional tests of individual components. They should be carried out prior to setting the system to work and undertaking the dynamic commissioning process set out in paragraph 11.27 onwards.

Note:

Before commencing commissioning, it is essential that builders' work in the area served by the system is complete. The doors and windows should be fitted, floor finishes applied, walls and ceilings completed and their final finish applied. Fans should not be run until the area is clean (see paragraph 10.6).

Standard of installation

11.20 During the installation of the system the following will be witnessed:

- that the plant and installations have been provided and installed in accordance with the design specification and drawings;
- that only approved sealants have been used in the installation;
- that all components function correctly;
- that the satisfactory sealing of access doors and viewing ports has been carried out;
- that the AHU airtightness test as per BS EN 1886 has been carried out;
- that air-pressure tests and air-leakage tests on ventilation ducting have been carried out in accordance with the methods set out in the BESA DW143 – 'Ductwork leakage testing' but the leakage rate to be not greater than 3% (it is usual to carry out these tests a section at a time as the ductwork is installed and before its insulation is applied. The results will be recorded in the commissioning manual);
- that gaps around doors and hatches are as specified in the design;
- that the permeability tests are carried out as per paragraph 12.17;
- that the correct operation of pressure stabilisers, control dampers, isolating and non-return dampers have been checked;
- that test holes have been provided in their specified locations and are sealed with suitable grommets;
- that control dampers are secured and their quadrants fitted correctly;
- that any interlocks are operative and in accordance with specification;
- that the electric circuits are completed, tested and energised;
- that electric motors have been checked for correct direction of rotation both at full speed and set back;
- that cooling and heating media are available at correct temperatures and pressures and in specified quantities;
- that the air-conditioning plant components and controls function correctly;

- that the air-conditioning plant interlocks and safety controls function correctly;
- that the plant is physically complete, insulation is applied and all ducts and pipework are identified as specified;
- that all service penetrations of the fabric of the area are sealed at the point of penetration (see also paragraph 10.30);
- that the building housing the ventilation plant is generally in a fit condition for commissioning and performance tests to commence, that is, windows, doors, partitions, ceilings, etc are completed, surfaces sealed and their final finish applied;
- that the areas containing the ventilation plant and those being served by it are clean;
- that access to all parts of the system is safe and satisfactory.

Certification of equipment

11.21 The following test certificates should be assembled by the commissioning team and be available for inspection at any time during the contract period. They will form part of the handover information and should be placed in the commissioning manual:

a. type test performance certificates for fans;

b. pressure test certificates for:

   i. heater-batteries;

   ii. cooling coils;

   iii. humidifier (if appropriate);

c. type-test certificates for attenuators;

d. type-test certificates for primary and secondary filters;

e. individual test certificates for EPA or HEPA air filters.

Equipment tests

11.22 Prior to setting the system to work the following will be witnessed and proving tests should be carried out as detailed:

Filters

11.23 The quality of filter housing and in particular, the seals, is a critical factor in maintaining the efficacy of the filtration system by ensuring that air does not bypass the filter elements. Therefore, the following checks should be made:

a. Filter seals should be fitted and in good condition.

b. Filters should be installed correctly with respect to airflow.

c. Bag filters should be installed so that the bags are vertical and their pockets free.

d. All filters should be checked to ensure they are free of visible damage.

e. EPA or HEPA filters should be scanned with an LSAPC to prove that they and their housings achieve the specified filter efficiency.

f. The differential pressure indicators should be checked for accuracy and that they are marked with the initial and final filter resistance.

Drainage arrangements

11.24 The drain should conform in all respects to the standard set out in paragraph 9.105 onwards. In addition, the following should be proved:

- that the drain tray is easily removable or completely accessible;
- that the drift eliminator (if fitted) is removable without the use of tools;

- that a borosilicate glass trap is fitted and is easily removable;
- that the trap discharge point to drain has a clear air-gap of at least 15 mm;
- that the pipework is supported so that the air-break cannot be reduced;
- that the drain system from each drain tray is independent up to the air-break.

11.25 The operation of the drainage system is then proved by introducing water into the duct at the drain tray and observing that it completely drains out. This check is to be repeated both at normal speed and set back once the fans have been commissioned. At this time the clear trap can be marked to indicate the normal water level with the fan running.

Fire dampers

11.26 The following will be witnessed and proving tests should be carried out as detailed:

- The operation of all fire and smoke dampers (fire dampers fitted with a thermally actuated "memory metal" mechanism should be proved using a hot air heat source).
- The access provided to enable the dampers to be visually inspected and/or reset should be sufficient for the purpose.
- Indication should be provided of the dampers' position (open/tripped).
- Indication of the fire dampers' location should be provided both on the ductwork and at a visible point on the building fabric if the ductwork is concealed.

Dynamic commissioning

Air-handling and distribution system

11.27 Before commencing the dynamic commissioning all rubbish should have been removed and the floors swept and wet-mopped (see paragraph 10.6). Any IPS panels should be in position, access hatches closed, light fittings in place and ceiling tiles clipped down as necessary.

11.28 The fan drive, direction of rotation, speed and current drawn should be set in accordance with their manufacturer's instructions. In the vast majority of healthcare applications, the fan output should be set to give a constant volume of air. This to be controlled by measuring the pressure drop across the fan using a sensing ring and associated volume controller that will automatically integrate the fan 'K' factor to determine and control the pre-set output air volume. The fan output will then in air volume terms remain constant regardless of changes of system resistance. The actual volume delivered will be related to the air-change rate for the application.

11.29 After the installation has been checked to ensure that it is in a satisfactory and safe condition for start-up, it should be set to work and regulated to enable the plant to meet its design specification. The proportional balancing method described in the CIBSE Commissioning Code A should be followed. The airflow rates will be set within the tolerances laid down in the design brief. This will normally be the design airflow rate +10%; –0%.

Note:

Plug fans are fitted with a measuring ring so that the design volume flow can be set when first started. It can then be reset as the airflow balance progresses. This method will result in the correct airflow with the least total system resistance once balancing is completed.

Air commissioning measuring equipment standards

11.30 All test and measuring equipment used will have a certificate to prove that its calibration has been checked within the previous 12 months at a facility using traceable national standards.

11.31 System performance should be measured at the main and branch duct supply and extract test points using a pitot and manometer or a thermal anemometer.

11.32 Supply and extract air volumes at the room terminals should be measured using a calibrated hood with back pressure compensation. If a hood correction factor is applied, it should be determined by a direct comparison with a duct measurement immediately adjacent to a terminal and not a general comparison between air at the main supply duct and the total as measured at the terminals. For multi-directional terminals a correction cross will be fitted in the measuring hood.

Note:

Measurements taken with a "home-made" hood or cone will not be accepted.

11.33 Measurements at extract grille faces should, where possible, be taken using a calibrated hood. Alternatively they may be measured with a rotating vane anemometer fitted with a hood, or as a last resort, scanned using a rotating vane anemometer and a free area factor applied. The grille face free area and factor used should be stated in the commissioning report.

Order of commissioning

11.34 When combined supply and extract systems are to be balanced and the area that they serve is to be at or above atmospheric pressure, the supply should be balanced first with the extract fan switched off, and then the extract balanced with the supply fan(s) on. The supply balance should then be rechecked.

11.35 For combined systems where the area that they serve is to be below atmospheric pressure, the extract should be balanced first with the supply fan switched off and then the supply balanced with the extract fan on. The extract should then be rechecked.

11.36 On completion of the balance, all volume airflows in supply and extract ducts and from grilles and diffusers will be measured and recorded. The true air-change rate can then be calculated from the data obtained.

Note:

For accuracy the room dimensions should be actually measured on site rather than deriving them from design drawings.

11.37 All supply and extract duct volume control dampers should be locked and their position marked and the fan motor settings noted and recorded.

11.38 All grille and diffuser volume control registers should be locked to prevent alteration and their final position marked.

Room air distribution

11.39 The pressure relief dampers and pressure stabilisers will be set to achieve the specified room differential pressures and locked. The grille direction control vanes and diffuser cones will be set to give the specified air movement pattern. Visualisation techniques may need to be employed to prove the required airflow pattern is being achieved and detect any adverse coanda effects (see paragraph 9.162).

Note:

When balancing combined supply/extract cascade ventilation systems (for example, operating suites, clean room suites), the airflow through the extract terminals in the adjacent corridors may need to be adjusted outside of their original design values in order to achieve the desired room pressure differentials.

Air-conditioning plant

11.40 The specified flow rate and/or pressure drops will be set for all heater-batteries, cooling coils and humidifiers. The methods described in the CIBSE Commissioning Codes W and R should be followed. On completion their regulating devices will be locked to prevent alteration.

Control system

11.41 The control system should not be commissioned until both the air distribution system and air-conditioning equipment have been commissioned.

11.42 Because of the specialised nature of control systems and the fact that each manufacturer's system will contain its own algorithms and settings, commissioning should be completed by the supplier, and witnessed and documented by a representative of the client (for example, the healthcare organisation's appointed validator).

11.43 In the vast majority of healthcare applications, the fan output should be set to give a constant volume of air. This to be controlled by measuring the pressure drop across the fan using a sensing ring and associated volume controller that will automatically integrate the fan factor to determine and control the pre-set output air volume. The fan output will then in air volume terms remain constant regardless of changes of system resistance. The actual volume delivered will be related to the air-change rate for the application.

Note:

Measuring the air pressure in the main supply duct and using that to set the supply fan speed as a percentage of its rated output and using that to set the extract fan speed as a percentage of the supply fan speed is not a satisfactory, accurate or acceptable way of controlling the desired supply and extract air volumes.

11.44 The location of all control and monitoring sensors should be checked and their accuracy proved.

11.45 The control system's ability to carry out its specified functions will need to be proved. The correct operation of any alarm systems should also be proved.

11.46 If the plant is provided with a "users" control panel in addition to the one located in the plantroom, the operation of both should be proved. This will typically apply to operating departments and laboratory systems.

Specific performance standards

11.47 The performance of the system should be measured and compared with information provided by the designer.

Plant capacity and control

11.48 When setting to work and proving the design, both the manufacturer of the air handling plant and the control specialist should attend site together and jointly commission the system.

11.49 If any doubt exists as to the capacity of the installed system, its ability to achieve the specified inside design conditions with

the plant operating at winter and summer outside design conditions should be proved. Artificial loads will be required in order to simulate the internal gains/losses and the outside design conditions.

11.50 On completion of the plant performance test, recording thermo-hygrographs should be placed in each room/area served by the plant and also the supply air duct upstream of the fog coil. The plant should be run for 24 hours with all doors closed. During this period the inside conditions should stay within the tolerances specified. Alternatively the BMS may be used to obtain the information required.

Noise levels (general)

11.51 The commissioning noise level is that measured with a sound level meter in the unoccupied room, taking account of the external noise together with the noise generated by the ventilation system. Chapter 8 and Table 1 in Chapter 4 give information for many applications.

11.52 The noise levels apply at the maximum velocity for which the system is designed to operate. Acoustic commissioning tests should be carried out with all plant and machinery running normally and achieving the design conditions of airflow, temperature and humidity.

11.53 An industrial-grade Type 2 sound level meter will normally be sufficient to check the noise level. Its accuracy should be checked using a calibrated sound source before use.

11.54 The noise level readings are to be taken at typical normal listening position 1.5 m above floor level and at least 1 m from any surface and not on any line of symmetry. In critical rooms the noise should be measured at the centre of the room and at the centre of each quarter. The mean of the five readings should then be calculated.

11.55 In the event of a contractual deficiency a Type 1 precision-grade sound level meter should be used and the noise level determined by the procedure given in Health Technical Memorandum 08-01.

Filter challenge

General ventilation filters

11.56 In-situ performance tests will not normally be required for primary and secondary filters and their housings. However, the filters should be visually inspected for grade, tears, orientation and fit within their housing. Filters should be clean and a replacement set available. Bag filters should be installed so that their bags are vertical and spaced so that air can move through them freely.

11.57 Air leakage around a filter housing significantly reduces the filter efficiency. The as-fitted filter housing and access door arrangement should not permit air to bypass.

EPA or HEPA filters (for exhaust protective enclosures and laboratories)

11.58 Pathogenic material may be discharged through damaged or badly installed EPA or HEPA terminal filters. The complete installation should be tested using the method set out in BS EN ISO 14644.

The challenge tests may be carried out using either of the following techniques:

- a light scanning airborne particle counter (LSAPC) and a natural challenge to detect leaks;
- dispersed oil particle (DOP) to provide the challenge and a photometer to detect leaks.

11.59 In both cases the upstream challenge should be measured. A measurement of particle penetration through a representative section of the EPA filter media is then taken and used as the

reference background level. These two readings enable the range of the detecting instrument to be set.

11.60 With an LSAPC the filter face is sampled at several points to establish the smallest non-penetrating particle size. This will directly relate to the grade of filter under test. The filter face, its seal and housing are then scanned, and if a significant number of particles at or above this size are detected, there is deemed to be a leak at or near the test position.

11.61 With DOP a challenge aerosol of inert particles of the type produced by a dispersed oil particle generator is introduced into the air, upstream of the EPA or HEPA filter. The downstream face of the filter, its mounting seal and housing are then scanned for leakage using a photometer. A leak should be deemed to have occurred if a steady and repeatable reading on the photometer at any point exceeds 0.01% of the upstream reading.

11.62 Should the EPA or HEPA filter fail this test, it will be replaced. Should the filter mounting seal or housing fail this test, it may be repaired and the test repeated.

Ventilation system commissioning records

11.63 Following commissioning, the main contractor will collate the individual commissioning reports together with the plant user manuals ready for handover.

11.64 The fire dampers will have been tested by a specialist, and a written statement detailing which fire dampers were tested, when and by whom should be provided. If any fire dampers in the system were not tested, they should be listed and appended to the statement.

11.65 The airflow balancing report compiled by the commissioning engineers should be available to the validator. The report should include copies of the equipment calibration certificates.

12.0 Acceptance testing: validation

12.1 All new and refurbished ventilation systems should be independently validated prior to acceptance by the client.

12.2 Validation differs from commissioning in that its purpose is to look at the complete installation from air intake to extract discharge and assess its "fitness for purpose as a whole". This involves examining the fabric of the building being served by the system and inspecting the ventilation equipment fitted as well as measuring the actual ventilation performance. Validation is not a snagging exercise; see the Note after paragraph 12.30.

12.3 Validation is a process of proving that the system in its entirety is fit for purpose and achieves the operating performance originally specified. It will normally be a condition of contract that "*The system will be acceptable to the client if at the time of validation, it is considered fit for purpose and will only require routine maintenance in order to remain so for its projected life.*"

Appointment of validator

12.4 In order to ensure that the complete system operates correctly it will be necessary to validate it as a whole from the air intake through to the extract discharge. It is unlikely that the client's in-house staff will possess the knowledge or equipment necessary to undertake this process. Validation should therefore be carried out by a suitably qualified competent engineer appointed by the client. The validator would be the client's AE(V) (see Chapter 2 in Part B of Health Technical Memorandum 03-01) or someone of similar standing who is familiar with the ventilation requirements for healthcare facilities. They will be completely independent of the system designers, contractors, suppliers, installers, commissioners and those who will subsequently operate and maintain the system.

12.5 To retain independence, the validator should be appointed and paid directly by the client. The validator will act as the client's representative to inspect the system, check its performance and recommend acceptance, or not, to the client.

Note:

"Client" means the healthcare provider, not a contractor or service provider.

Design proposal review

12.6 It is essential that whoever has been appointed to carry out the final validation acceptance of the system should be involved in the initial client's brief and design specification, preferably prior to the project being put out to tender. They will then be fully aware of the client's requirements and any limiting factors.

Note:

While it is beneficial to involve the client's validator in the design process, it should be remembered that the appointed designer carries the "design risk" and advice from the validator will not obviate this.

12.7 It is important that the validator understands the complete project and not just the obvious ventilation aspects. Decisions about the type of ceilings, doors, access hatches, fire compartmentation, floor markings, room functions, their adjacency and the proposed workflow patterns all have a direct effect on the likelihood of being able to achieve the desired ventilation performance. It is not sufficient to consider the ventilation in isolation.

12.8 During this process any derogations proposed by the contractor/supplier should be clearly defined, agreed and documented with the client (for example, through the VSG). All parties will then be clear as to what will be the acceptable standard of installation and performance when finally validated.

12.9 The ventilation designer(s) should provide the validator with system information listed in Table 11. The information should be in the form of an annotated drawing for each ventilation system to be validated. They should also provide any other design or specification information that will assist the validation process.

12.10 The contract arrangement should give the validator the right to visit the site as often as they deem necessary during the contract period.

First fix inspection

12.11 The validator should carry out a physical walk-around inspection of the installation at a point in the project when the AHU is "on site" and the main and branch ductwork is for the main part installed, but prior to the ductwork being concealed behind wall panelling or ceilings.

12.12 If possible, the following airtightness tests should be witnessed during the inspection:

- AHU installation leakage (BS EN 1886);
- supply and extract duct leakage (BESA DW/143);
- initial permeability test (see paragraph 12.17).

12.13 The quality of the installation, compliance of the AHU, suitability of the basic installation, location and future accessibility of commissioning dampers, location and compliance for testing of fire dampers, etc, can all be assessed during the visit.

12.14 When validating large projects that have many AHUs, it is worthwhile to visit the AHU manufacturer to inspect a specimen unit and agree its compliance before all remaining units are built and transported to site. At that time the leakage and deflection tests can be demonstrated by the AHU supplier in their factory.

12.15 Once units are delivered to site, it is useful to get all mechanical and electrical services connected to a specimen AHU. The location of pipework joints, drain points, anti-vibration couplings, isolating and control valves can all be agreed, as can the route of cable ways and control wiring. The

object will be to create an agreed "exemplar unit". If all other AHUs are installed in an identical fashion, they will normally be considered compliant at the time of final validation.

12.16 On completion of the first fix visit the validator should provide the client with a short report identifying items that are not compliant with the specification.

Permeability testing

12.17 The following areas will require permeability testing:

- isolation suites of any type;
- operating suites of any type;
- pharmacy aseptic preparation facilities;
- IAP cleanrooms in sterile services departments;
- category 3 and 4 containment facilities;
- any other area specified within the contract.

The methodology for permeability testing is set out in BSRIA document BTS 3 – 'Air permeability testing of isolation facilities'.

12.18 An initial permeability test should be witnessed at first-fix stage when the envelope of the suite is physically complete but before wall, ceiling and floor finishes are applied. The objective will be to find and eliminate any construction leaks (for example, between a floor slab and curtain wall) before they become covered up during the fit-out stage (see paragraph 10.30).

12.19 A full permeability test in accordance with the methodology given in BSRIA BTS 3 will be carried out at practical completion to ensure that all service penetrations have been adequately sealed.

Note:

Any leaks discovered during the test are to be sealed at the point of penetration of the building fabric envelope and NOT at the gaps around IPS panels, ceiling hatches or bedhead trunking covers, etc (see also paragraph 10.30).

Follow-on inspections

12.20 Dependent on the size and complexity of the installation, a second and further inspection visits may be required. The validator should attend site as frequently as necessary in order to try to eliminate any installation issues as the project develops and while trades are still in attendance, rather than having to resolve them at the time of final acceptance.

Final acceptance inspection: validation

12.21 The commissioning of a ventilation system will normally be carried out by the suppliers of the various elements. The final acceptance validation will check that all of the elements work as a whole to achieve the project aim.

12.22 The following regime of inspection and testing should be applied to the validation of all new and refurbished ventilation systems. It may also be applied to systems that have undergone significant changes such as the replacement of a fan or other major component.

Basic requirements

12.23 The area served by the ventilation system to be validated should be physically complete with final finishes applied. The doors should fully close against the design pressure differential with IPS panels fitted and any access hatches closed. All ventilation plant serving it should be

operating correctly and have been commissioned in accordance with the project contract.

Note:

In projects on existing sites, the area of the building being built/refurbished is often sealed off from the "in use" part to prevent dust penetration. At final validation the seals need to be at least temporarily breached in order to be able to determine the ventilation performance in "normal" conditions. If this is not possible, validation will be conditional on a final "actual" performance check when the seal is removed at the time of handover.

12.24 The area served should be free of any rubbish, debris, obvious dust and have been wet-mopped before the validation is undertaken.

Note:

There is no need to clean the area to the point that the validator needs to gown up in order to enter it. A certain amount of disturbance to hatch seals, ceilings, panels, etc will be inevitable during the validation process, so the area will require a final "clinical" clean prior to being taken into use.

12.25 The validation process should be a continuation of the earlier site inspections and will in many cases be carried out in parallel with the commissioning process.

12.26 Unless stated elsewhere in the design specification, the conditions in the principal space served by the ventilation system being validated should be stable and within the given ranges.

Temperature:	18–22°C dry bulb.
Humidity:	30–70% Relative humidity.

12.27 Any test or measuring equipment used should have a certificate to prove that it has been calibrated within the previous 12 months at a facility using traceable national standards.

12.28 In the case of a noise meter, its "matched sound source" should have a certificate to prove that it has been calibrated within the previous 12 months at a facility using traceable national standards. The noise meter should be calibrated to the sound source on each occasion that it is used.

12.29 The validator has the right to either witness readings taken by the commissioning team or to independently take such readings and measurements as they deem fit in order to satisfy themselves as to the actual performance of the system.

Validation process

12.30 The validation process should follow the sequence given below. Any failures discovered during the process should be rectified before continuing. The validator should check the following:

- the location of the air intake and discharge and their position relative to each other and other intakes and discharges;
- inspection and cleaning access to the vermin mesh and as necessary throughout the installation;
- the security, suitability of and access to the AHU location;
- sufficient space and access arrangements for service and maintenance;
- that the AHU is uniquely identified (see paragraph 13.17) and complies with the minimum standards set out in Chapter 9;

- that the AHU and distribution system have been leak-tested and comply with the design;
- that the AHU and supply ductwork system are clean and free of visible dust;
- that all fire and smoke dampers have been inspected and tested for correct installation and operation. A certificate to that effect, signed and dated by the inspector and tester, will be available for inspection;
- that the area served by the ventilation system is complete and free from significant defects that could invalidate the validation process;
- that the supply and extract airflow rates are in accordance with the design +10%; –0% and the system terminals are in balance. Note that the total supply and extract air volumes measured at the AHU should equate to those measured at the terminals. A discrepancy in the totals would indicate a leak in the system which should be resolved before proceeding further;
- that the air-change rate calculated from the measured airflow and room dimensions accords with the design specification;
- that the room differential pressure regime is in accordance with the design and that if pressure stabilisers are fitted, they operate correctly and silently;
- the air velocity at a specific location(s) if required in the application specification;
- that the noise level does not exceed the design value;
- that the system indicators correctly and clearly show whether or not the ventilation system is in an operational state;
- that any user controls fitted operate correctly (for examples of "cause and effect testing", see Appendix 10);
- that the temperature and humidity in the space being ventilated are accurately indicated on the user panel and that they can be adjusted within the specified limits, if applicable;
- that the estates control functions operate correctly and the plant condition is clearly shown both on the plant control panel and at the BMS/ BEMS interface;
- that the fire cause and effect strategy has been demonstrated and operates correctly. This may be carried out by others, in which case a statement signed and dated by the person carrying out the test will form part of the handover information;
- that any additional tests called for in the project specification have been carried out and witnessed by the validator or the client's appointed expert.

Note:

Validation is not a "snagging" inspection. The main contractor has presented the installation as being complete, fully commissioned, achieving the specified level of performance and ready for handover. The validator's role is to check on behalf of the client that the contractor is correct in that assertion.

If the validator discovers that there are a significant number of snags and non-compliances, the validation should be terminated. It is the contractor's responsibility to snag the project, carry out remedial works and re-present the installation for acceptance. The validator will then need to repeat the validation

process. The client is entitled to deduct any resulting additional validation fees incurred from the contractor.

12.31 It is vitally important to complete the validation process before the system is accepted by the client. Due to the nature of the ventilation installation and the intensity of use in the healthcare setting, it will not be possible to correct any faults or non-compliances once the system has been accepted and taken into use. There are also medico-legal aspects around taking a non-compliant system into use. Pre-announced handover or occupancy dates are not a reason for the validator or client to accept a non-compliant installation.

Validation report

12.32 Following validation, a full report detailing the findings will be produced and sent to the client's lead project manager. The report should conclude with a clear statement on whether the system achieved or did not achieve the standard set out in the agreed design specification.

12.33 The client's lead project manager should lodge a copy of the validation report with:

- head of the user department;
- infection prevention and control;
- estates and facilities.

Additional specialist tests

12.34 Certain critical areas will require additional testing and validation in addition to the process given above.

UCV theatres

12.35 The following regime of inspection and testing should be applied to the validation of new installations designed to provide ultra-clean conditions in an operating suite. The test regime has been devised to ensure that the system as installed fully achieves the operational requirement for these systems as set out in Chapter 8.

UCV canopy validation procedure

12.36 The validation procedure set out in paragraph 12.30 onwards should have been satisfactorily completed prior to attempting to validate the UCV canopy. The operating suite to be validated should be physically complete with final finishes applied. All ventilation systems serving it should be operating correctly and delivering their design airflow rates.

12.37 Tests to validate the suitability and performance of a UCV canopy should be undertaken in the order that they appear below. If an item fails to meet the required standard it should be rectified and successfully retested before passing on to the next test.

Summary of test regime

12.38 Leakage tests should ensure that:

- the UCV canopy is correctly assembled and sealed so that no air will bypass the filters;
- the canopy terminal filters are correctly sealed in their housings;
- the canopy terminal filters are of a uniform quality and undamaged.

12.39 Air velocity measurements should ensure that:

- a sufficient quantity of air is being delivered by the canopy;
- the airflow has sufficient velocity to reach the operating site plane.

12.40 An entrainment test should ensure that contaminants arising outside of the UCV canopy footprint are not drawn into it.

12.41 Visualisation techniques should gain an understanding of the overall system performance.

12.42 Noise measurement should ensure that working conditions are satisfactory.

12.43 Control system "cause and effect" checks should ensure that the system operates and indicates as specified (for example, see Appendix 10).

12.44 The successful completion of the test regime will ensure that the system will be effective if used correctly.

Test and measuring background conditions

12.45 The entire theatre suite should be clean and free from debris and visible dust. It should be in a condition that if the validation is successful the suite will only require a final clinical clean before being taken into use (see paragraph 12.24).

12.46 All doors should remain closed when readings and scans are being taken.

12.47 The conditions in the operating theatre should be stable and within the given ranges.

Temperature:	18–22°C dry bulb.
Humidity:	30–70% Relative humidity.

Test and measuring equipment

12.48 Any test or measuring equipment used should have a certificate to prove that it has been calibrated within the previous 12 months at a facility using traceable national standards.

12.49 In the case of a noise meter, its "matched sound source" should have a certificate to prove that it has been calibrated within the previous 12 months at a facility using traceable national standards. The noise meter should be calibrated to the sound source on each occasion that it is used.

Test grid – vertical flow canopies

12.50 A test grid should be constructed on the floor within the UCV canopy footprint as projected by the inside dimensions of the side walls or boundary air curtain. A suitably marked test sheet will provide a consistent standard of test grid.

Note:

The entire clean zone footprint of the UCV canopy will be designated by a contrasting coloured inlay in the floor covering. A line marked on or cut into the floor covering is not sufficient and will not be accepted.

12.51 The test grid should comprise test squares of 280 mm × 280 mm dimension.

12.52 The test grid should be aligned along the centre lines of the canopy footprint with its centre under the centre point of the canopy.

12.53 Any test square with 80% of its area within the UCV footprint should be used as a test position.

12.54 An inner zone will be designated that is not less than 36% of the total footprint. It will be made up of a number of test squares distributed symmetrically about the canopy footprint centre line. Regardless of the size or shape of the canopy footprint, the inner zone will comprise a minimum grid of 6 × 6 test squares.

12.55 Unless specified otherwise, a test position should be in the geometric centre of a test square.

12.56 Test position 1 will be the left-most test square in the row nearest to the operating theatre wall that houses the

theatre control panel. (For an example of a grid for a 2.8 m × 2.8 m canopy, see Figure 3.)

UCV canopy leakage tests

12.57 The diffuser screen fitted below the face of the canopy terminal filters should be lowered or removed while the leakage tests are being carried out.

12.58 The installed terminal EPA filters are to be checked to ensure that their grade accords with the design specification and that their performance has been certified by their manufacturer.

Test equipment

12.59 An LSAPC connected to an isokinetic fishtail scanning probe will be used to detect the size and number of particles present.

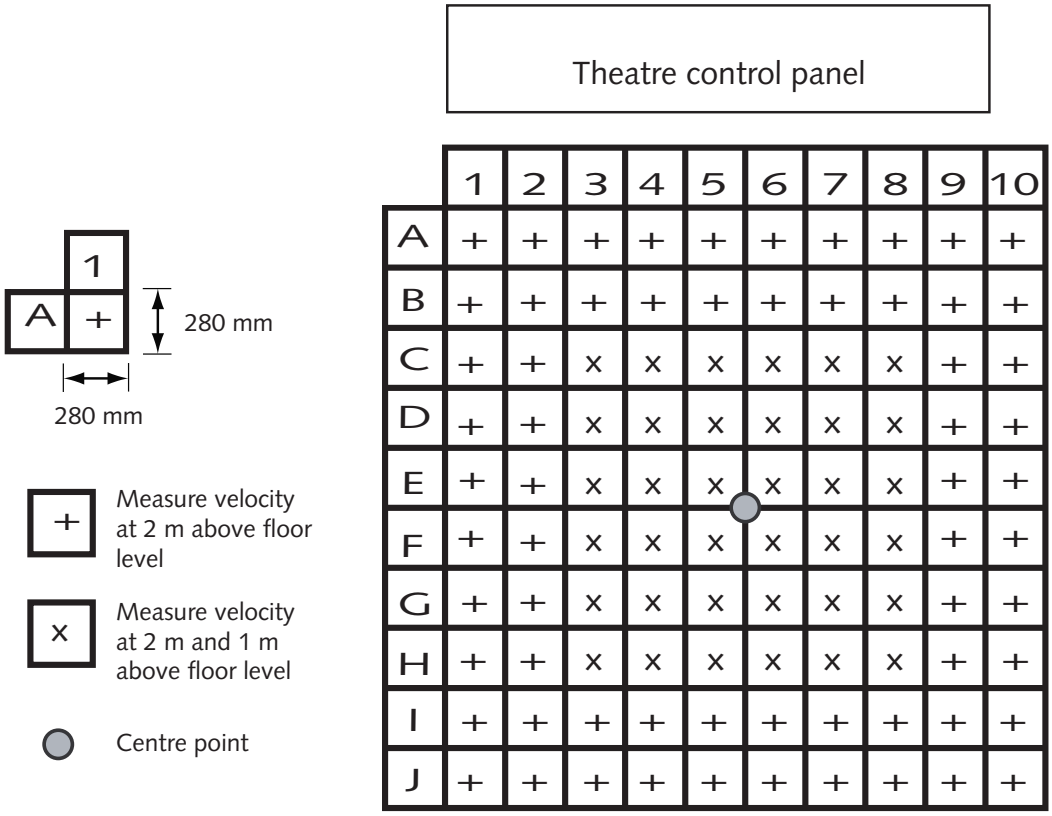
12.60 Spot readings are taken at several filter faces to establish the smallest non-penetrating particle size. If particles at or above this size are detected when subsequent scans are made, there is deemed to be a significant leak at, or near, the test position.

UCV canopy clean zone leak test

12.61 The test will confirm that there is no unfiltered air leakage in the canopy.

12.62 The construction joints and service penetration points under the UCV canopy within its side walls or boundary air curtain should be scanned to prove that there are no leaks.

Figure 3 Example of a test grid for a 2.8 m × 2.8 m UCV terminal



Note:
For larger UCV terminals, add extra (280 mm x 280 mm) test squares symmetrically around the periphery of the grid and increase the inner zone in accordance with the guidance in paragraphs 12.50–12.56 of Health Technical Memorandum 03-01 Part A.

12.63 A leak is defined as a significant and repeatable rise above the background level.

Terminal EPA filter seal leak test

12.64 The test will confirm that there is no unfiltered air bypassing the EPA filter seal.

12.65 Each EPA filter seal should be scanned to prove that there are no leaks.

12.66 A leak is defined as a significant and repeatable rise above the background level.

EPA filter media leak test

12.67 The test will confirm that the EPA filters have not sustained damage while being installed.

12.68 The face of each EPA filter should be scanned to prove that there are no leaks.

12.69 A leak is defined as a significant and repeatable rise above the background level.

Vertical flow UCV canopy air velocity tests

Test setup

12.70 The canopy face diffuser screen should be in place for these tests.

12.71 Take spot readings to establish that the room is within the specified temperature and humidity test conditions.

12.72 Set out the test grid as described previously.

12.73 Swing the operating lamp arms and any other stem arms so that they align to present the least resistance to airflow, are perpendicular to the front edge of the test sheet and face the back edge. Any lamp and equipment heads should as far as practicable be outside of the UCV canopy footprint (see photographs).

Test instrument

12.74 The measuring instrument should be a thermal anemometer with a digital readout. The instrument resolution should be at least 0.01 m/s, have a tolerance of ±0.015 m/s or 3% and be calibrated down to 0.15 m/s or lower. An alternative instrument may be used providing it is of no lesser specification.

Test method

12.75 The instrument should be mounted on a test stand and set to take a mean reading over a 10-second sample interval.

12.76 The test instrument should record readings automatically for later download or be connected to a printer.

12.77 The test stand should be positioned on each test point in turn and the reading taken when the instrument has stabilised.

12.78 When taking a reading, the test person should not stand within the same quadrant as the test instrument.

12.79 Readings are to be taken at the test positions with the instrument probe facing the wall housing the theatre control panel – commencing at the first test position. Readings are taken either working along the rows from left to right or for all test positions in one quadrant at a time.

12.80 When all test positions under one half of the canopy have been covered, readings of temperature and humidity are taken at the specified height in the centre of the canopy. The readouts from the theatre control panel should be recorded at this time.

12.81 Having completed one half of the test grid, the operating lamp arms and any other stem arms should be swung round through 180° and the test stand reversed so that the wall housing the theatre control panel is behind the test person. Readings

are recommenced starting at the right of the test row and working from right to left or a quadrant at a time, as above.

UCV canopy high level discharge velocity test

12.82 Measurements of air velocity are to be taken at every test position 2 m above floor level and the results averaged. The **average** of the total readings taken is to be not less than:

- 0.38 m/s for a canopy with no side walls or side walls that terminate at 2 m above floor level.
- 0.30 m/s for a canopy with side walls that terminate 1 m above floor level.

12.83 For UCV canopies that are an assembly of two or four units, each fed by a recirculation fan, the average air velocity for each unit should not exceed ±6% of the measured average velocity for the canopy.

UCV 2m air velocity test set-up

UCV canopy low level air velocity test

12.84 Measurements of air velocity are to be taken at each of the inner zone test positions 1 m above floor level.

12.85 The measured velocity at every test position in the inner clean zone should be not less than 0.20 m/s.

UCV 1m air velocity test set-up

UCV canopy entrainment test

Rationale for the entrainment test

12.86 The performance of a UCV canopy may be compromised by room air being drawn into the ultra clean airflow, a phenomenon known as entrainment. Significant levels of entrainment could lead to microbial contamination of items left exposed on instrument trolleys laid out beneath the canopy.

12.87 UCV canopies having permanently fitted side walls that terminate 1 m above floor level do not need to be tested, as the walls physically prevent entrainment.

Principle of the test

12.88 A source of particles is produced outside of the UCV canopy footprint and is used to challenge the system. A sample probe and detector are placed within the ultra clean airflow and used to determine the percentage penetration of the test particles at predefined locations under the UCV canopy footprint. The source and sample probe are moved in tandem around the UCV canopy and pairs of readings taken at the detector, from which the percentage penetration at specified locations is calculated. The degree of penetration should be below specified maximum limits if entrainment is to be declared not significant.

Test setup

12.89 The challenge will be provided by using non-EPA-filtered air emerging from the preparation room via the pressure stabiliser or transfer grille and ducted to the specified release position.

12.90 The canopy face diffuser screen should be in place for these tests.

12.91 The test is performed without any theatre equipment in place beneath or closely adjacent to the UCV canopy. All doors in the theatre suite should be closed and remain so for the duration of the test.

12.92 The operating lights and support booms should be moved to a central position beneath the canopy and raised to 2 m above floor level, so as not to interfere with the peripheral airflows (see photograph).

12.93 Spot readings are taken at the centre of the canopy, 1 m from floor level, to establish that the room is within the specified temperature and humidity limits (see paragraph 12.47).

12.94 The test grid is set out as described previously (see paragraph 12.50).

Test equipment

12.95 The source unit will be a fan/blower or other method that ducts non-EPA-filtered air (see paragraph 12.89) and expels it via a delivery head mounted on a test stand or clamped to the UCV canopy sidewall at the specified release position to provide the particle challenge. The challenge air will be delivered vertically downwards from a position 2 m above floor level alongside the outside edge of the side wall or in line with the downward air curtain if the canopy does not have side walls. The challenge airflow velocity should be the same as the measured average velocity at the 2 m level for the canopy under test.

UCV entrainment test setup

12.96 The detector will be an LSAPC capable of sampling a minimum of 28.3 L of air (1 ft^3) per minute and providing readings for particle sizes from to 5 µm to 0.3 µm. The instrument should be compliant with the requirements of BS EN ISO 14644. An alternative instrument may be used providing it is of no lesser specification.

12.97 The sampling head will be an isokinetic fishtail scanning probe mounted horizontally on a test stand 1 m above floor level and connected to the LSAPC by a hose no longer than 2 m.

Test positions and orientation of source and detector sampling probe

12.98 The test positions will be at the centre of each test square, as defined for the velocity test (see paragraph 12.50).

12.99 For rectangular UCV canopies, measurements of penetration are to be taken at the four corner test squares of the test grid and at intermediate positions along the line of test squares between the corners. The number of intermediate test positions will be as equally spaced as possible around the periphery, with not fewer than three and not more than five complete test squares between test positions.

12.100 A further series of measurements are to be obtained around the periphery of the inner zone (defined in paragraph 12.54). Measurements of penetration are to be taken at the four corner test squares of the inner zone of the test grid and if necessary at intermediate positions along the line of test squares between the corners as equally spaced as possible, with not fewer than three and not more than five complete test squares between test positions.

12.101 The centre of the challenge particle source delivery head is aligned with the centre of the designated test square, with its longer edge against the outer edge of the side wall or air curtain and delivering the challenge 2 m above floor level. The air containing challenge particles is directed vertically downward. Where there is physical interference due to obstructions such as gas pendants, the source will be moved to the next available non-obstructed test square location nearest to the stipulated test position. The sampling probe will then also be moved to remain opposite the source.

12.102 In the case of non-rectangular canopies, an interpretation of the above strategy should be adopted that will yield a no less searching examination of the unit's ability to control entrainment.

Test method

12.103 A measurement of particle penetration through a representative section of the EPA filter media is to be taken. The smallest non-penetrating particle size will be used as the reference background level and set in the detector instrument. The detector instrument should be set to take a reading over a 15-second sample interval and record the number of particles at the non-penetrating particle size determined above.

12.104 An initial sample of air at the source delivery head should be taken to check that there are sufficient particles of the considered size present. The challenge will be considered suitable if:

a. the particles are within the size range 5 to 0.3 µm and thus capable of remaining airborne for a substantial time.

b. the particles should not be able to penetrate the canopy EPA filters in sufficient numbers to cause a background count that is more than 0.1% of the challenge count.

c. the number of particles present will enable a minimum of three logarithm (1000-fold) range of counts to be recorded between the source and background readings. A concentration of approximately 10^5 particles per cubic metre of source air has been shown to be adequate.

Note:

The same equipment should be used to measure both the challenge source and penetration so as not to bias results through particle losses within the test equipment.

12.105 The sampling probe of the detector instrument is mounted on a test stand with its orifice facing outwards horizontally from the centre of the UCV canopy, 1 m above floor level. The sampling probe will be orientated at right angles to the partial wall when sampling along the sides of the test grid but will be set to bisect the angle when measuring at the corner test positions. (See Figure 4 for test locations and see photograph of entrainment test equipment on page 131.)

12.106 The test will commence at the first test position, this being designated the left-most corner of the test grid when facing the wall housing the theatre control panel. The penetration will also be measured at the corresponding test point on the inner zone commencing at the corner nearest to the first test position.

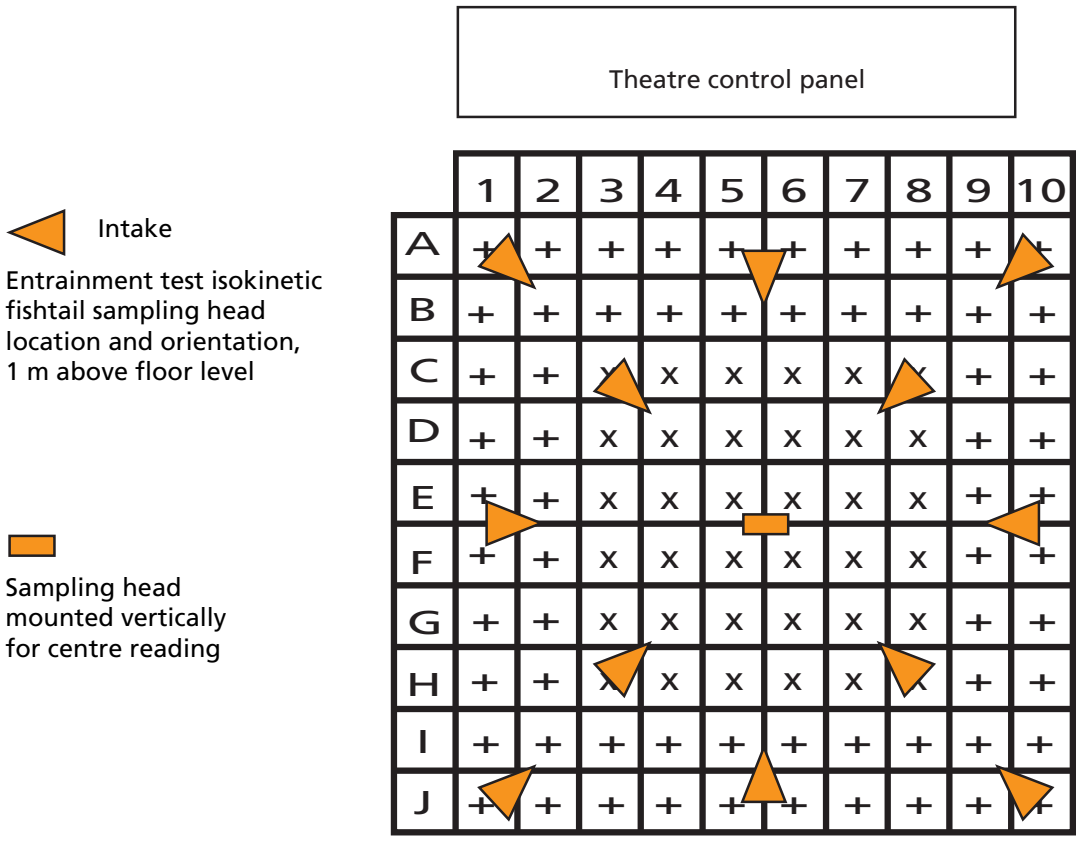
When these tests have been completed, the source distribution head and sampling probe will be moved to the next test positions, working around the test grid in a clockwise direction.

12.107 The test stands will be positioned on each test point in turn and a pair of readings (challenge, then penetration) taken when the instrument has stabilised.

12.108 When taking a reading, the test person should stay within the UCV canopy footprint but on the side opposite the sampling probe.

12.109 A single measurement will be taken at the geometrical centre of the UCV canopy footprint. The centre measurement will be taken with the sampling probe mounted vertically 1 m above floor level.

Figure 4 Entrainment test locations for a 2.8 m ×2.8 m UCV terminal



Note:
Test grid layout is as for Figure 3. Entrainment test set-up and guidance is given in paragraphs 12.86 onwards.

For this test the challenge source distribution head will be placed at the test position that yielded the greatest penetration at the periphery of the canopy footprint.

Analysis and interpretation

12.110 The following standard is to be achieved:

a. Penetration to be no greater than 10% of the challenge at each test position in the outer zone.

b. Penetration to be no greater than 1% of the challenge at each test position in the inner zone.

c. Penetration to be no greater than 0.1% of the challenge at the centre of the test grid.

12.111 If a result is close to or above the given limits, a further reading should be obtained using a longer time base (1 minute) and the penetration should not exceed the given limit.

UCV canopy flow visualisation

12.112 The use of smoke to gain an understanding of the overall performance of the canopy may prove useful at this stage in the validation process but cannot be relied on to produce a contractually definitive measure of performance.

UCV canopy noise level

12.113 An industrial-grade sound level meter to BS EN 61672 Type 2 fitted with a muff will be used to check the noise level. The instrument should be calibrated using a matched sound source prior to each set of readings.

12.114 The noise level readings are to be taken at a typical normal listening position 1.5 m above floor level and at least 1 m from any surface and not on any line of symmetry. Measurements should be taken under the centre of each quadrant and in the centre of the canopy, and the five readings averaged.

12.115 The readings should be taken with the UCV canopy at operational speed and repeated with it at set back.

12.116 For UCV operating suites, the noise level should not exceed:

- operating theatre and spaces without doors that are open to it (for example, the scrub): 53 dB(A);
- all other peripheral rooms of the suite: 48 dB(A).

UCV terminal control system checks

Temperature

12.117 The readings of temperature taken under the UCV canopy should be within ±1°C of the readout on the theatre control panel.

Humidity

12.118 The readings of humidity taken under the UCV canopy should be within ±5%RH of the readout on the theatre control panel.

Direct reading differential pressure gauges

12.119 The differential pressure across the terminal filter should be measured to confirm the accuracy of the indicated reading of any gauge.

Control functions

12.120 The operation of all control functions provided on the theatre control panel should be checked for conformity

with the design specification (see Appendix 10).

12.121 If an auxiliary panel has been fitted, its interlocking with the main theatre control panel control functions will be checked for conformity with the design specification.

Panel indicator lights

12.122 The panel indicators should illuminate as appropriate when the control functions are selected, or warning levels are reached (see Appendix 10 for an example "cause and effect" test regime).

BMS interface

12.123 The operation, monitoring and alarm functions should be checked for conformity with those set out in the design specification.

UCV theatre microbiological tests

12.124 There is little value in performing microbiological sampling in an empty operating theatre supplied with ultra clean ventilation. The foregoing filter challenge tests, air velocity measurements and entrainment test will have proved that the system operates satisfactorily and achieves the contracted level of performance. The EPA filters will remove bacteria-sized particles from the air supplied through the UCV canopy. Therefore, there will be an insignificant number of bacterial and/or fungal cfus present until the theatre is actually used.

12.125 Following full validation, in-use microbiological sampling during a surgical procedure will not be required unless specified by the client's VSG.

UCV operating suite validation report

12.126 Following validation, a full report detailing the findings will be produced and sent to the client's lead project manager. The report should conclude with a clear statement on whether the UCV operating suite as a whole achieved or did not achieve the standard set out in the agreed design specification.

12.127 The client's lead project manager should lodge a copy of the report with:

- theatre manager;
- infection prevention and control;
- estates and facilities.

Pharmacy aseptic preparation facilities

12.128 The following regime of inspection and testing should be applied to the validation of new installations. The test regime has been devised to ensure that the system as installed fully achieves the operational requirement for these systems as set out in EUGGMP and the design specification.

Basic requirement

12.129 The validation procedure set out in paragraphs 12.1–12.33 should have been satisfactorily completed prior to attempting to validate the aseptic preparation facility. The suite to be validated should be physically complete with final finishes applied and have been completely cleaned. All ventilation systems serving it should be operating correctly and delivering their design airflow rates.

Aseptic preparation facility validation procedure

12.130 Tests to validate the suitability and performance of the aseptic preparation facility should be undertaken in the order that they appear below. Should an item fail to meet the required standard it should be rectified and successfully retested before passing on to the next test.

Summary of test regime

12.131 Challenge tests should ensure that:

- the supply terminal HEPA filters are sealed in their housings so that no air will bypass them;
- the terminal filters are of a uniform quality and undamaged.

12.132 Differential pressure measurements should ensure the correct pressure cascade.

12.133 Particle counting should be carried out at a specified number of test positions in order to determine the individual clean room classification in accordance with ISO EN 14644.

12.134 Control system checks should ensure that the system operates as specified.

12.135 Microbiological sampling should check the air quality.

Test and measuring conditions

12.136 While validating the aseptic preparation facility, the conditions in the clean rooms should be stable and within the given ranges.

Temperature:	19–23°C dry bulb.
Humidity:	30–70% relative humidity.

Test and measuring equipment

12.137 Any test or measuring equipment used should have a certificate to prove that its calibration has been checked within the previous 12 months at a facility using traceable national standards.

Supply terminal EPA or HEPA filter seal leak test

12.138 The test will confirm that there is no unfiltered air bypassing the EPA or HEPA filter seal.

12.139 Each EPA or HEPA filter seal should be scanned using a light scattering airborne particle counter (LSAPC) to prove that there are no leaks.

12.140 A spot reading will be taken at the face of the filter to determine the background particle level. A leak is defined as a significant and repeatable rise above the background level.

Terminal (EPA or HEPA) filter media leak test

12.141 The test will confirm that the terminal filters have not sustained damage while being installed.

12.142 The face of each terminal filter should be scanned using an LSAPC to prove that there are no leaks.

12.143 A leak is defined as a significant and repeatable rise above the background level.

Clean room particle count

12.144 The test will confirm the number and size of particles present and therefore the classification of the clean room in terms of ISO 14644 or EUGGMP as specified in the project brief.

12.145 The number of test positions is determined by reference to Table A.1 in ISO 14644-1.

12.146 The complete test methodology will be as set out in ISO 14644.

Clean room biocontamination control

12.147 BS EN 17141 gives details on clean room biocontamination control.

Radiopharmacy aseptic preparation facilities

12.148 Validation will be as for a pharmacy aseptic preparation facility.

12.149 Additional radiological tests as specified in the project brief will be required. These will be carried out and/or witnessed by the client's appointed specialist.

Inspection, assembly and packing (IAP) rooms in sterile services departments

12.150 Validation will be as for the standard practice described in paragraphs 12.1–12.33.

12.151 The pressure cascade and associated automatic monitoring sensors and alarms should be tested for correct operation in accordance with the design specification.

Note:

The detail of the sealing between the instrument washers, transfer hatches and sterilizers that penetrate the walls of the IAP room will be critical in attaining the specified room pressure.

12.152 Following the satisfactory validation, the IAP room should be physically cleaned using specialist contractors. Particle counts at locations related to the floor area as set out in table A.1 of ISO 14644 Part 1 will then be taken to establish whether the room achieves a Class 8 cleanroom standard.

Containment level 3 laboratories

12.153 Validation will be as for the standard practice described in paragraphs 12.1–12.33.

12.154 The room will be subject to a permeability test as set out in paragraph 12.17.

12.155 The pressure cascade and associated automatic monitoring sensors and alarms should be tested for correct operation in accordance with the design specification.

Isolation rooms

12.156 Validation will be as for the standard practice described in paragraphs 12.1–12.33.

12.157 See Health Building Note 04-01 Supplement 1 for details of the test regime.

Microbiological sampling

12.158 It is essential that all parts of the validation test specified above have been successfully completed and the areas thoroughly cleaned prior to any microbiological sampling.

12.159 Microbiological sampling will not normally be required for either general or local exhaust ventilation (LEV) systems unless otherwise specified within the contract.

12.160 The procedure for carrying out microbiological sampling in clean rooms is set out in ISO 14644.

13.0 Information

Records required

13.1 There is a requirement under the Building Regulations to provide documentary evidence of the design, commissioning and subsequent performance of ventilation systems as well as recommended maintenance routines (Building Regulations. 2010, Part 8, Paragraph 39).

13.2 Electronic records should be in a format that is compatible with the client's archive and retrieval system.

Handover

13.3 The following general information is required at plant handover:

a. "as fitted" drawings of the plant showing the location of all items and listing the size of ducts, grilles and diffusers together with their factors;

b. "schematic" drawing of the air distribution system showing design and actual airflows from all outlets together with the design and actual airflows in each duct. The duct centre correction factors should be given and the grille factors;

c. the location of all volume control dampers should be marked on the "as fitted" and "schematic" drawings;

d. a floor plan of the area served by the plant showing all doorways, hatches, transfer grilles, pressure relief dampers, pressure stabilisers, supply and extract terminals. The total supply and extract volumes should be shown for each room served by the plant. The volume flow and direction of flow through transfer grilles, pressure relief dampers and pressure stabilisers should also be shown, together with the room pressures in pascals measured with regard to atmospheric pressure. For operating suites the "key" door should be identified;

e. a fire plan of the area served showing the fire zone and location of all fire and smoke dampers and detectors. An explanation of the ventilation strategy in the event of an in-zone fire, adjacent zone fire or smoke being drawn into the air handling unit from an outside source should be provided.

f. wiring diagrams for all electrical equipment associated with the air handling systems including motor control circuit details and any interlocking and safety devices such as emergency stop buttons adjacent to the item of plant;

g. manufacturer's operating instructions and "setting to work" guidance for

all specialist components incorporated in the systems;

h. a schematic of the control system showing the location of all plant sensors;

i. control algorithm(s) of the actual plant operation and the set points entered during commissioning together with the control panel access codes and keys.

Plant design information

13.4 The following plant design information is required at plant handover:

a. a simple statement of the design intent;

b. a description of the plant's intended mode of operation;

c. winter outside design temperature in °Cdb;

d. winter outside design humidity in % saturation;

e. winter room supply air design temperature in °Cdb;

f. winter room supply air design humidity in % saturation;

g. winter inside design temperature for each room in °C;

h. winter inside design humidity for each room in % saturation;

i. summer outside design temperature in °Cdb;

j. summer outside design humidity in % saturation;

k. summer room supply air design temperature in °Cdb;

l. summer room supply air design humidity in % saturation;

m. summer inside design temperature for each room in °C;

n. summer inside design humidity for each room in % saturation;

o. winter psychrometric chart showing the condition of the air between all items of plant and the design outside, supply and room air conditions;

p. summer psychrometric chart showing the condition of the air between all items of plant and the design outside, supply and room air conditions;

q. the design mass airflow rate used to size the plant in kg/s;

r. the design volumetric flow rate in m^3/s.

Individual equipment information

Heater-batteries including energy recovery

13.5 The following information concerning heater-batteries is required at plant handover:

a. the size of the battery, number of passes and fin spacing;

b. the design flow and return temperatures and flow rate in L/s;

c. the pressure drop across the water side of the battery in Pa;

d. the number of phases, supply voltage, current drawn and number of steps if electric;

e. the maximum rated capacity of the battery and actual design rating in kW;

f. the design and actual face velocity in m/s;

g. the pressure drop across the air side of the battery in Pa;

h. the design on and off coil air temperature and humidity at winter and summer design conditions.

Cooling coils

13.6 The following information concerning cooling coils is required at plant handover:

a. the size of coil, number of passes and fin spacing;

b. the design flow and return temperatures and flow rate in L/s if chilled water;

c. the pressure drop across the water side of the coil in Pa;

d. the supply pressure and mass flow rate if direct expansion;

e. the maximum rated capacity of the coil and actual design rating in kW;

f. the contact factor;

g. the design sensible and latent cooling loads in kW;

h. the design and actual face velocity in m/s;

i. the pressure drop across the air side of the coil in Pa;

j. the design on and off coil air temperature and humidity at summer design conditions.

Humidifiers

13.7 The following information concerning humidifiers is required at plant handover:

a. the size of the humidifier and number of lances;

b. the supply pressure and mass flow rate of the steam;

c. the number of phases, supply voltage, current drawn and number of steps if electric;

d. the maximum rated capacity of the humidifier and actual design rating in L/hour;

e. the design and actual face velocity in m/s;

f. the design upstream and downstream air temperature and humidity at winter design conditions.

Filters

13.8 The following information concerning filters is required at plant handover:

a. the size of the filter and number in bank;

b. its grade;

c. the design and actual face velocity in m/s;

d. the initial pressure drop across the filter when clean in Pa;

e. the final pressure drop across the filter when dirty in Pa;

f. the manufacturer's name and filter identification code.

Fans

13.9 The following Information concerning fans is required at plant handover:

a. the size of the fan and its type;

b. the fan curve;

c. speed and direction of rotation;

d. the drive motor frame size;

e. the number of phases, voltage and maximum design and actual current drawn;

f. the design and actual delivered air volume in m^3/s;

g. the fan suction pressure at high and low speed in Pa;

h. the fan delivery pressure at high and low speed in Pa;

Attenuators

13.10 The following information concerning attenuators is required at plant handover:

a. the size of the attenuator and number in bank;

b. the design and actual face velocity in m/s;

c. the initial pressure drop across the attenuator in Pa;

d. the upstream sound level in dB(A); the downstream sound level in dB(A).

System information

13.11 The preservation of information and records of ventilation systems and their performance is a legal requirement. It is therefore essential that when new systems are completed, full information as to their purpose, design, layout and actual commissioned performance are handed on to the client. If any derogations were agreed from this standard, they should be noted and the reason for them explained. The system information if electronic (for example, BIM model) should be in a form that is compatible with the client's IT standard and can be accessed and searched by it.

13.12 In new "green field" developments an inventory of the installed ventilation systems should be compiled. In existing developments the client will normally have an inventory of their installed systems, and all new systems should be added to it.

13.13 The inventory will be subdivided into the following categories:

- Local exhaust ventilation systems (LEV) – note these are statutory items.
- Critical healthcare ventilation systems (CHV).

(These are systems the loss of which would seriously limit the delivery of healthcare – for example, operating suite, SCBU, critical care areas, interventional imaging suite, aseptic preparation facility.)

- General ventilation system [supply and extract] (GVS).
- General extract systems (GES).
- Systems installed for smoke clearance in the event of a fire, classed as smoke and heat exhaust ventilation systems – (SHEVS) (for example, smoke extract fans in stairwells, automatic smoke clearance dampers in atria).

Note:

During the design and contract process, ventilation systems are often given "construction" codes for drawing reference and site identification purposes. It is imperative that prior to handover the actual identification codes and labels affixed to the systems conform to the inventory in use at the site or desired by the client. Each system code should be unique and conform to the categorisation format for the client's inventory given above.

For ease of future reference, a list of design and construction references for drawings and plant, cross-referenced to the client's building designations and plant inventory codes, should be produced.

13.14 For each ventilation system the inventory should contain the following details:

- A unique system identification code (for example, LEV 001; CHV 001) as appropriate.
- The location of the ventilation fan unit or supply and extract AHU(s).
- The location of the fresh air inlet.
- The location of the extracted air discharge.
- The specific area(s) served by the system.

- The date the system was installed.
- The date the system was validated and accepted by the client.

13.15 Each ventilation system should have a logbook (physical or electronic) that contains the following information:

- The unique system identification reference.
- Purpose of the system.
- Date of installation.
- Details of the installed equipment and ductwork layout.
- Detail of the fire plan and location of fire and smoke dampers.
- Design performance parameters (for example, airflow rates, air-change rates, pressures).
- Commissioned date and performance.
- Record of the system validation and acceptance.
- Records of the annual inspection and verification.
- Maintenance records and plant information (for example, fan specifications and filter sizes).

13.16 The records should be linked to the inventory and stored in such a way as to be readily available in the event of plant breakdown or other incident.

13.17 Every ventilation system should be clearly identified with a permanent label. The label should show in lettering 100 mm high the inventory reference code of the AHU and clearly identify the area that it serves. The label should be mounted with screws or rivets in an easily visible place near the fan of the unit adjacent to the local electrical isolator. The system control panel should have a duplicate label. Any subsystems and the principal branch ducts should be similarly labelled.

13.18 The nature of air and direction of flow should be clearly marked on all ducts using the symbols given in BS 1710.

13.19 All airflow test-points should be clearly identified with a permanent label and the design information given (for example, TPS 1 – Anaesthetic supply; 400 × 300; Design 185 L/s).

13.20 If two ventilation systems supply a common room or an outlier from another zone, the room identification label should state the relevant ventilation identification codes, for example: Theatres 5&6 Utility; [CHV 012 and CHV 015], as should the labels on their individual AHUs.

13.21 Any ventilation system that conveys a hazardous substance or is affected by a hazardous radiation must be clearly marked with the appropriate symbol.

Fire and smoke dampers

13.22 A complete schedule of dampers fitted, their location and unique identification code should be provided.

13.23 A statement of when they were tested and by whom should be included.

Spares

13.24 Unless otherwise agreed with the site maintenance department, spares should be stored on a rack in the entrance of the relevant plantroom and preserved from casual damage or contamination.

13.25 The scale of spare fans to be provided should relate to the number of AHUs using fans of the same size. The spare fans should be pre-wired with power and control connectors so that when used they are plug and play.

13.26 A complete set of new filters should be handed over.

13.27 A complete set of any other consumable item installed in the installation should be handed over.

BIM status

13.28 If the installation was modelled using BIM during construction, the BIM model should be brought up to date and all asset tags incorporated prior to handover.

13.29 Training for estates staff who will be tasked with keeping the BIM model in date should be given, ideally while the original BIM team is available.

Maintenance routines

13.30 Any product or installation-specific maintenance routines should form part of the handover documentation and, if necessary, training.

13.31 Information on routine inspection and maintenance is given in Part B of Health Technical Memorandum 03-01.

Expected service life

13.32 Air handling units (AHUs) have an expected service life of 20 years. Part B of this HTM states that ventilation systems should be taken out of service, deep cleaned, their controls renewed and recommissioned after 10 years. The handover information will both assist this process and help inform the selection of replacement plant.

Additional end user information

13.33 The information itemised above is intended to fulfil the contract requirement and provide a record for the client and their appointed operational management and maintenance teams. There is also a need in some circumstances to provide the end-user with information as to the role that the ventilation system will play in protecting them and their patients from airborne contaminants.

13.34 In operating suites and interventional imaging suites of any type, a simplified plan of the suite showing the principal direction of air movement should be displayed at the entrance to the suite. The following bullet points should be appended to the plan:

- The air supplied to each room is intended to dilute any airborne contaminants.
- The airflow between rooms will ensure that contaminants do not enter.
- People are the main source of airborne contaminants; they disperse such contaminants as they move around: the more people, the more movements, the more airborne contaminants.
- Optimum conditions exist when all doors are closed.
- In order to ensure that the system operates correctly and efficiently:
  - routine checks should be carried out of the system performance;
  - the system should be taken out of use periodically to carry out essential maintenance.

13.35 The VSG should advise if other applications require similar explanatory information.

Staff training

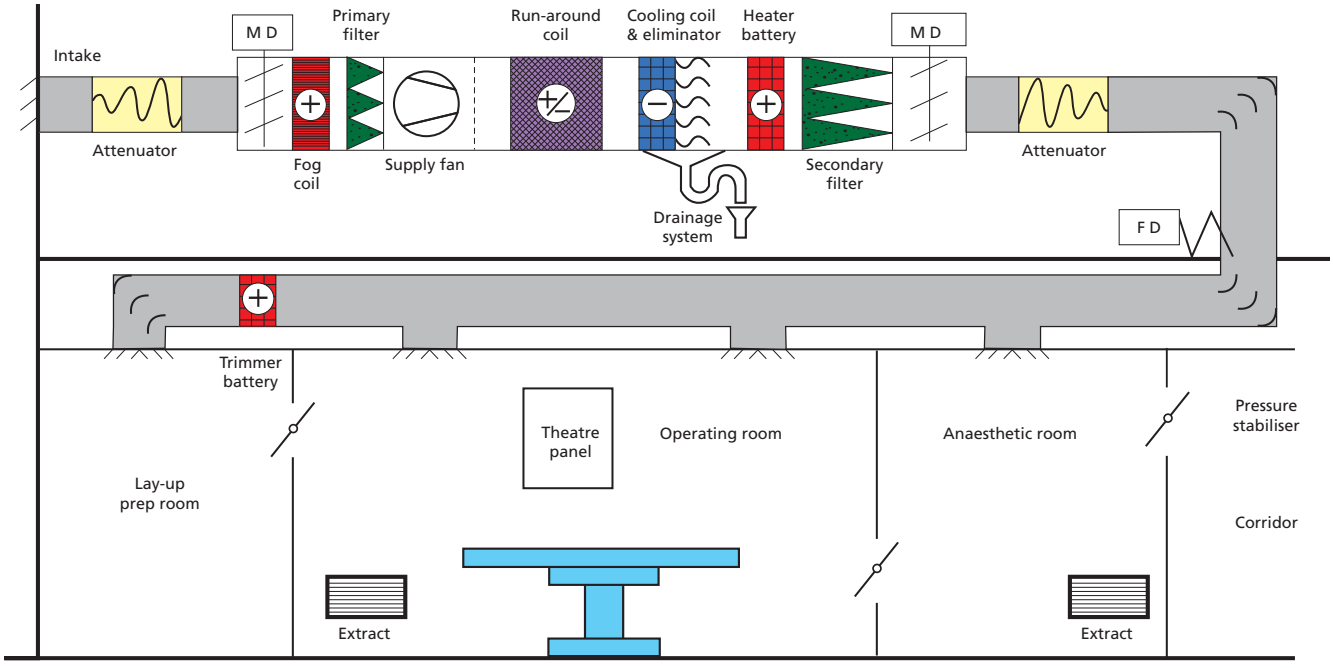
13.36 On completion of the project, training in the correct use, operation and routine maintenance of the installed systems should be given as appropriate to the following staff groups:

- the end-users;
- those who will operate and maintain the installed systems.

Appendix 1: Typical AHU plant layouts

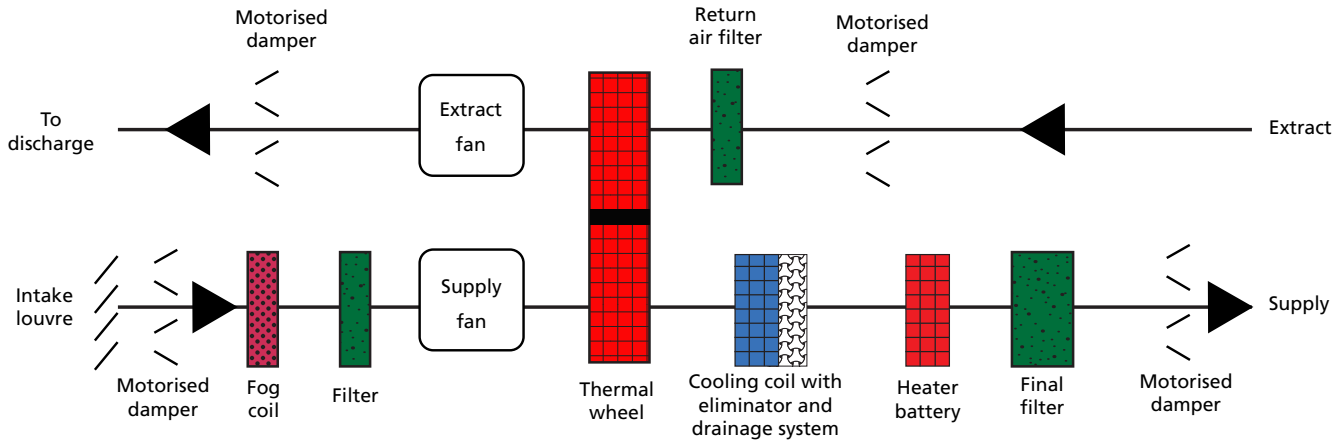
Supply AHU with remote extract unit

Figure A1 Schematic of typical operating suite AHU with energy recovery by run-around coil from a remote extract fan unit



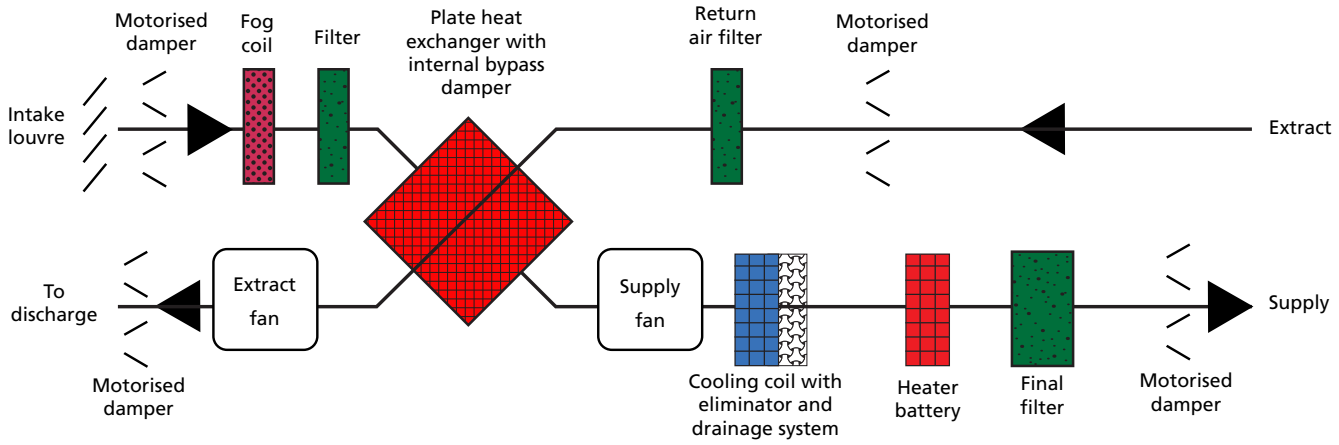
Double-stacked supply and extract AHU

Figure A2 Schematic of typical double-stacked AHU with energy recovery by thermal wheel



Note: Other configurations are possible

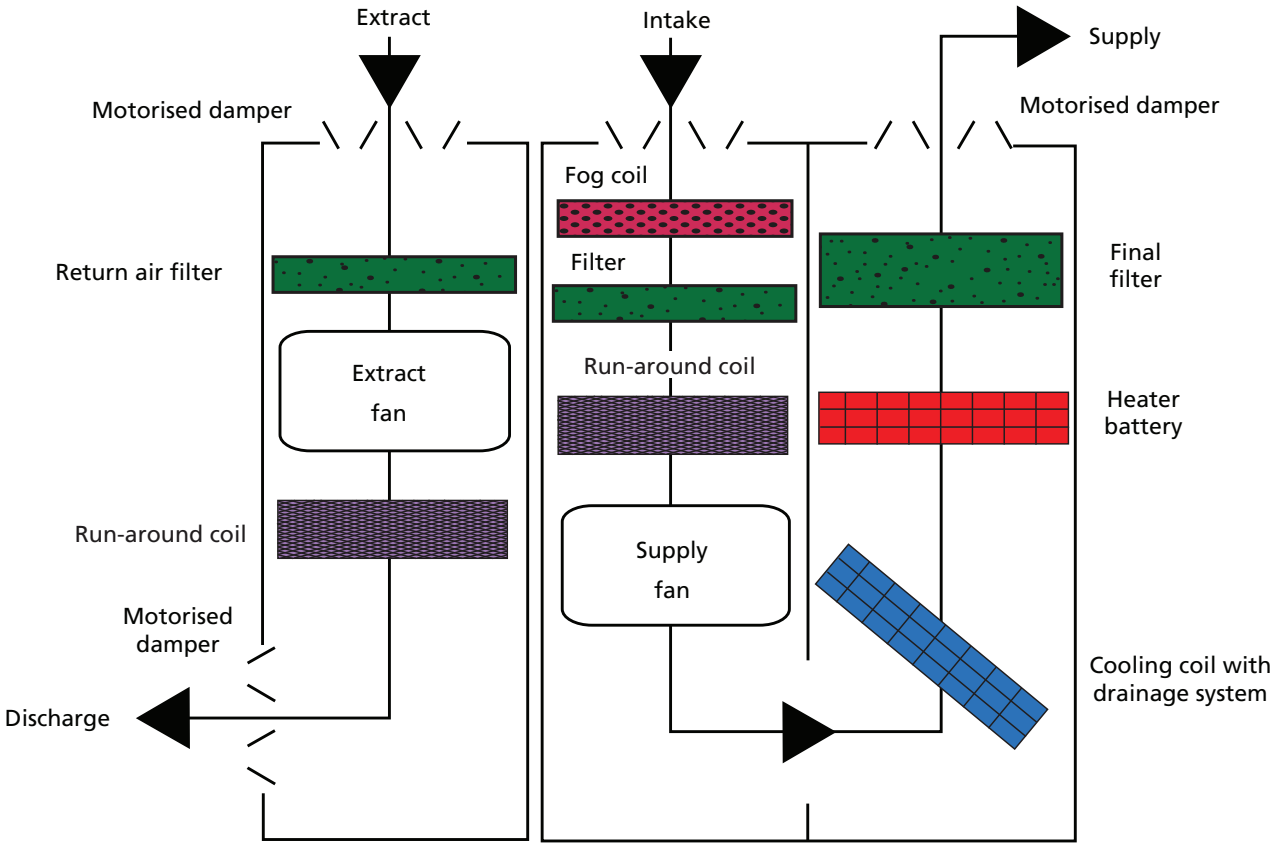
Figure A3 Schematic of typical double-stacked AHU with energy recovery by plate heat exchanger



Note: Other configurations of the fan positions are possible

Cabinet AHU

Figure A4 Schematic of typical cabinet-style AHU with energy recovery by run-around coil



Note: Other types of compact vertical AHUs are possible

Appendix 2: Summary of design conditions

Application	Ventilation	Air-change rate (ac/h)	Pressure (Pascal – Pa)	Supply filter grade (BS EN 16798)	Noise (dB(A))	Temp (°C)	Comments (for further information see Chapter 8)
General ward (level 0 and 1 care)	S/N	6	–	SUP2	35	**18–28**	
Communal ward toilet	E	6	–ve	–	45	–	
Single room	S/E/N	6	0 or –ve	SUP2	35	**18–28**	
Single room WC	E	3	–ve	–	45	–	
Clean utility	S	6	+ve	SUP3	45	**18–22**	
Dirty utility	E	6	–ve	–	45	–	
Ward isolation room (PPVL)	S	10	Lobby +10 Room 0	SUP2	35	–	See Health Building Note 04-01 (Supplement 1)
Infectious diseases isolation room	E	10	–5	SUP2	35	–	See Table 4
Neutropaenic patient ward	S	10	+10	H12	35	–	See Table 3
Critical care areas (Level 2 and 3 care)	S	10	+10	SUP1	35	–	Isolation room may be –ve pressure or PPVL. See Table 3
Birthing room	S & E	10	0	SUP2	45	*20–25*	See Table 5
NICU/SCBU	S & E	10	+ve	SUP1	35	*20–28*	Isolation room may be –ve pressure
For general and UCV operating suites and associated rooms, see specific guidance in Chapter 8 and typical design solutions in Appendix 7							
Operating department recovery room	S & E	15	0	SUP2	45	*18–25*	Provide clean airflow path
Catheterisation room	S & E	10	+ve	SUP2	45	*18–22*	

Application	Ventilation	Air-change rate (ac/h)	Pressure (Pascal – Pa)	Supply filter grade (BS EN 16798)	Noise (dB(A))	Temp (°C)	Comments (for further information see Chapter 8)
Interventional or non-interventional Imaging room of any type	S & E	10	+ve	SUP2	48	–	Stable conditions as specified for the imaging equipment
Sedation recovery room as in paragraph 8.16	S & E	10	S/E	SUP2	45	**18–28**	
Endoscopic procedure room	S & E	10	-5	SUP2	40	*20–25*	See Table 2
Endoscope reprocessing wash room	E	10	–ve	–	45	–	
General treatment room	S & E	10	Neutral	SUP2	45	*20–25*	See Table 2
Emergency department waiting area	S & E	6	–	SUP2	–	*18–25*	See Table 2
Containment level 3 laboratory	#	>20	#	H14*	–	*18–22*	# See ACDP guide; *Filter in extract See Table 4
Post-mortem room	S & E	S = 10 E = 12	–ve	SUP2	45	**18–22**	Provide clean airflow path
Specimen store	E	–	–ve	–	–	–	Fan accessible from outside of store

Notes:

Waiting and circulation areas should be directly or indirectly ventilated to provide a comfortable environment and control airborne contamination and odours.

18–22°C indicates the range over which the temperature may float.

18-22°C indicates the range over which the temperature should be capable of being controlled.

S = Suppy

E = Extract

N = Natural ventilation where possible

Appendix 3: Hierarchy of cleanliness

Class	Room	Nominal pressure (Pa)[a]	Airflow rate for bacterial contaminant dilution	
			Flow in or supply (m^3/s)	Flow out or extract (m^3/s)
Sterile	Preparation room		See standard schemes in Appendix 7 for recommended design values	
	(a) lay-up	35		
	(b) sterile pack store	25		
	Operating theatre	25		
	Scrub bay[b]	25		
Clean	Sterile pack store	+ve	6 ac/h	–
	Anaesthetic room[c]	15[c]	The greater of 15 ac/h or 0.15	The greater of 15 ac/h or 0.15
	Scrub room	15	–	0.10 min[d]
Transitional	Recovery room	0	15 ac/h[e]	15 ac/h[e]
	Clean corridor	0	(See note f)	7 ac/h
	General access corridor	0	(See note f)	7 ac/h
	Changing rooms	3	7 ac/h	7 ac/h
Dirty	Service corridor	0	–	(See note g)
	Utility room	–5 or 0	–	0.40 or 0.10

Notes:

a. Nominal room pressures are given to facilitate setting up of pressure-relief dampers, the calculation process, and the sizing of transfer devices. In practice, the resultant pressures are not immutable provided the desired airflow rates and movement directions are achieved.

b. An open or semi-open bay is considered to be part of the operating theatre; a low-level extract under the scrub trough is required. (See Chapter 8 paragraph 8.45 onwards and "Note" for more information.)

c. For design purposes, anaesthetic should be assumed to be at 15 Pa. When commissioning, equal to or greater than 10 Pa is considered suitable.

d. May need to be increased if scrub is large to promote scouring.

e. 15 ac/h is considered necessary for the control of anaesthetic gas (see Appendix 9).

f. Supply airflow rate necessary to make up 7 ac/h after taking into account secondary air from cleaner areas.

g. No dilution requirement. Temperature control requirements only.

Appendix 4: Leakage flows in m^3/s through closed door gaps

Type	Pressure difference (Pa)							
	5	10	15	20	25	30	35	40
Single door	0.03	0.05	0.06	0.06	0.07	0.08	0.09	0.10
Single door + half	0.04	0.06	0.07	0.08	0.09	0.10	0.11	0.12
Double door	0.05	0.08	0.10	0.11	0.12	0.13	0.14	0.15

Designers' notes:

The door gaps assumed are 4 mm along the bottom, 3 mm at the top and sides, and 2 mm between double leaves.

If doors are fitted with cold smoke seals, these will significantly reduce the door leakage rate when new and undamaged. It is therefore recommended that provision for the design leakage be factored into the size of the appropriate transfer grille or pressure stabiliser. Failure to do this will result in air-gap whistles and doors being held partially open by air pressure.

Factory-assembled door-sets with a steel frame and pre-hung leaves are becoming common. There is effectively no leakage across these doors when closed. Therefore, when this type of door assembly is fitted, the door leakage can be ignored and the design airflow into the room reduced accordingly. The design airflow would then become that required either (i) for open door protection (Appendix 5), or (ii) to achieve the specified air-change rate – whichever is the greater.

Appendix 5: Recommended airflow rates in m^3/s through a doorway between rooms of different cleanliness to control cross-contamination

Room class		Dirty	Transitional	Clean	Sterile
Sterile	Hatch	0.3	0.24	0.18	
	Single door	0.47	0.39	0.28	0 or 0.28[a]
	Double door	0.95	0.75	0.57	0 or 0.57[a]
Clean	Single door	0.39	0.28	0 or 0.28[a]	
	Double door	0.75	0.57	0 or 0.57[a]	
Transitional	Single door	0.28	0 or 0.28[a]		
	Double door	0.57	0 or 0.57[a]		
Dirty	Single door	0	Open single door = 0.80 m x 2.01 m high		
	Double door	0	Open double door = 1.80 m x 2.01 m high		

Designers' notes:

The degree of protection required at an open doorway between rooms is dependent on the degree of difference in cleanliness between them.

Flow-rate required between rooms within the same class tends to zero as class reduces.

a. If two rooms are of equal cleanliness, no flow is required (in practice there will be an interchange in either direction) and the design of the air movement will assume zero airflow. In certain cases, however, interchange is not permitted, and a protection airflow of 0.28 is assumed in the design – for example, in the case of a preparation room used as a "lay up".

Appendix 6: Typical approximate pressures in an operating suite when a given door is open

Door open between	Typical approximate resultant pressure in these rooms (Pa)	Typical approximate effect on other rooms	
		Room	Pressure (Pa)
Operating theatre and corridor or Scrub bay and corridor	0	Anaesthetic Preparation – lay-up Utility Preparation – sterile pack store	0 12 –6 5
Operating theatre and anaesthetic room (or other series room with double doors)	17	Preparation – lay-up Utility Preparation – sterile pack store	26 –9 22
Operating theatre and Utility room or Operating theatre and preparation room	25	No change	
Anaesthetic room and corridor (or other series room with double doors)	0	Preparation – lay-up Utility Operating theatre Preparation – sterile pack store	30 –6 20 25
Preparation room and corridor or Utility room and corridor	0	No change	
Utility room and outer corridor	0	No change	

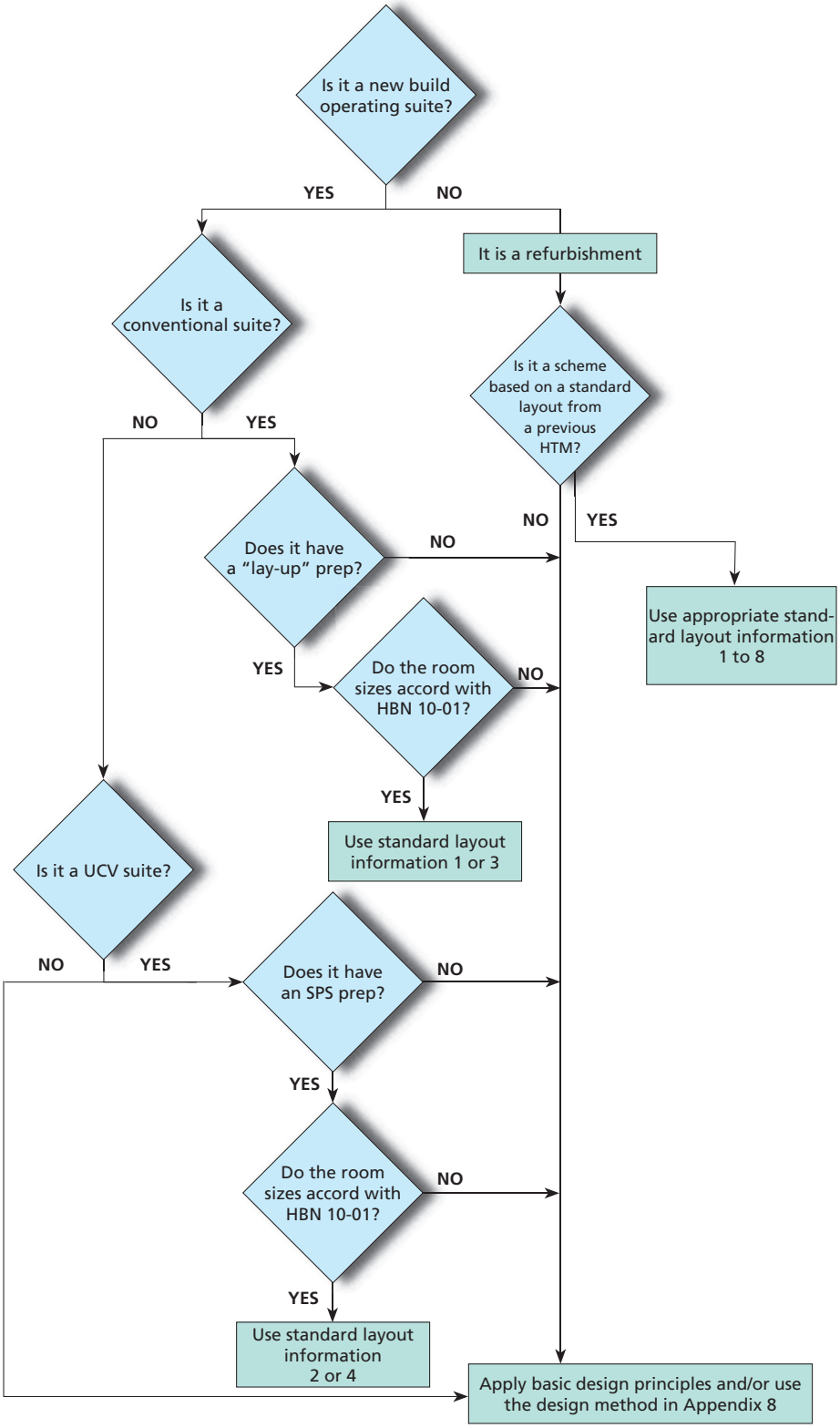
Notes:

The room differential pressure protects against reverse flows when the door is closed.

The flow of air through a doorway protects against reverse airflow when the door is open.

Pressure stabilisers control flow and ensure a known airflow path between rooms when doors are closed and also reduce backflow between rooms when doors to other rooms are open.

Appendix 7: Operating suite design logic



Standard layout 1 – Two-corridor conventional operating suite with "lay-up" prep

Room	Size (m^3)‡	Air-change rate (ac/h)	Nominal pressure (Pa)	Flow rate (m^3/s)
Theatre	165	≥22	25	Primary = 0.73 From Prep = 0.28 Total = 1.010
Anaesthetic	57	15	Design 15 Commissioned ≥10	0.24
Lay-up prep	36	≥22	35	0.28**
Scrub	*	–	25	–

Notes:

‡ Derived from Health Building Note 10-01 (2021). If room sizes differ from those given, recalculate the design air flows to achieve the air change rate or door protection.

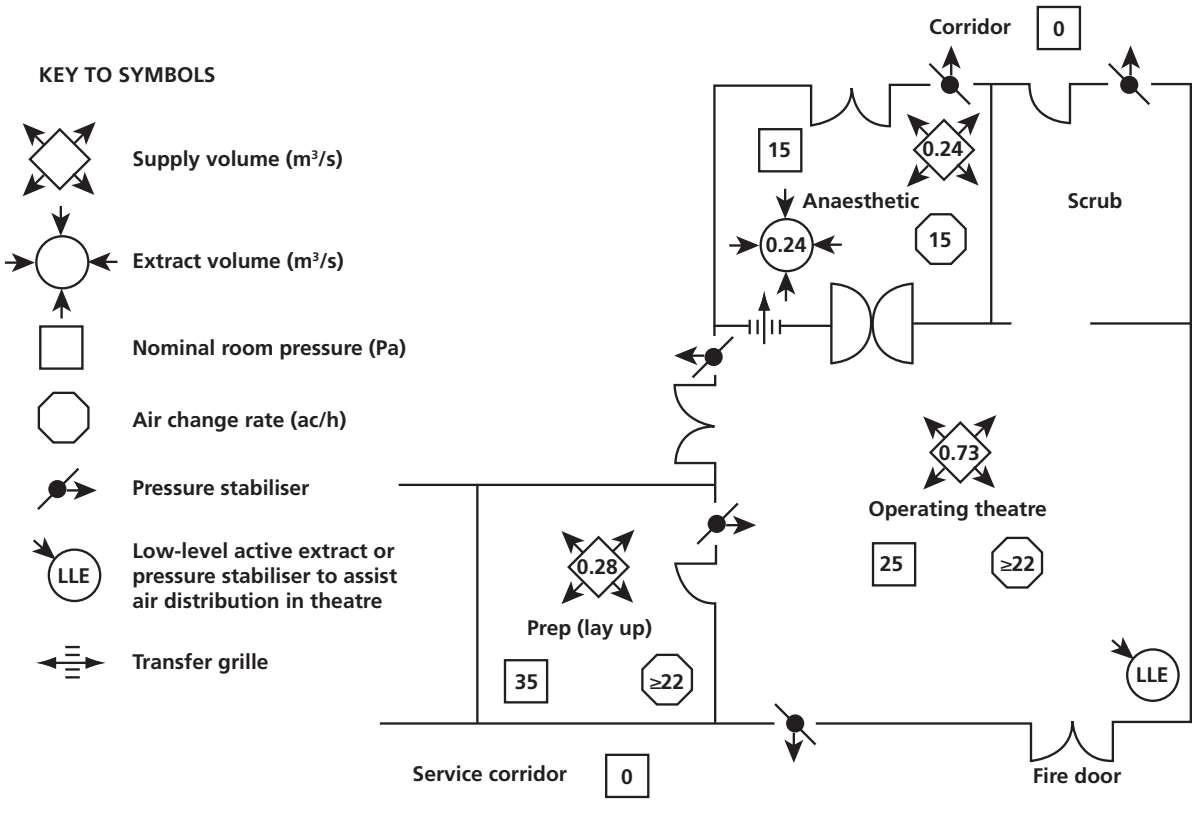
*This is a separate scrub and is not considered as being part of the theatre volume.

**Interchange is not permitted between the theatre and lay-up prep; therefore, as in Appendix 5, an airflow protection of 0.28 m^3/s is required as a minimum (but see also the "designers' notes" in Appendix 4).

N.B.If the lay-up prep also has a door or hatch to the corridor, its supply airflow volume would increase to 0.35 m^3/s

The volume of air to be extracted from the theatre should be determined by subtracting the airflow required for door protection at the key door from the total air entering the space. The balance should be equally divided between the passive or active extract locations.

The extracts within the theatre and scrub may be either passive and fitted with pressure stabilisers or active and connected to the extract system. They should where possible be located at low level and positioned to promote the active ventilation and scouring of all areas of the space (see paragraph 8.92). Air transfer from theatre to anaesthetic room may be by pressure stabiliser or transfer grilles (see paragraphs A8.51 and A8.52 in Appendix 8). The anaesthetic room extract will be at low level (see Appendix 9).



Standard layout 2 – two-corridor UCV operating suite with SPS prep

Room	Size (m^3)‡	Air-change rate (ac/h)	Nominal pressure (Pa)	Flow rate (m^3/s)
Theatre	165	≥22	25	# 1.01
Anaesthetic	57	15	Design 15 Commissioned ≥10	0.24
Sterile pack store prep	36	10	25	0.10
Scrub	*	–	25	–

Notes:

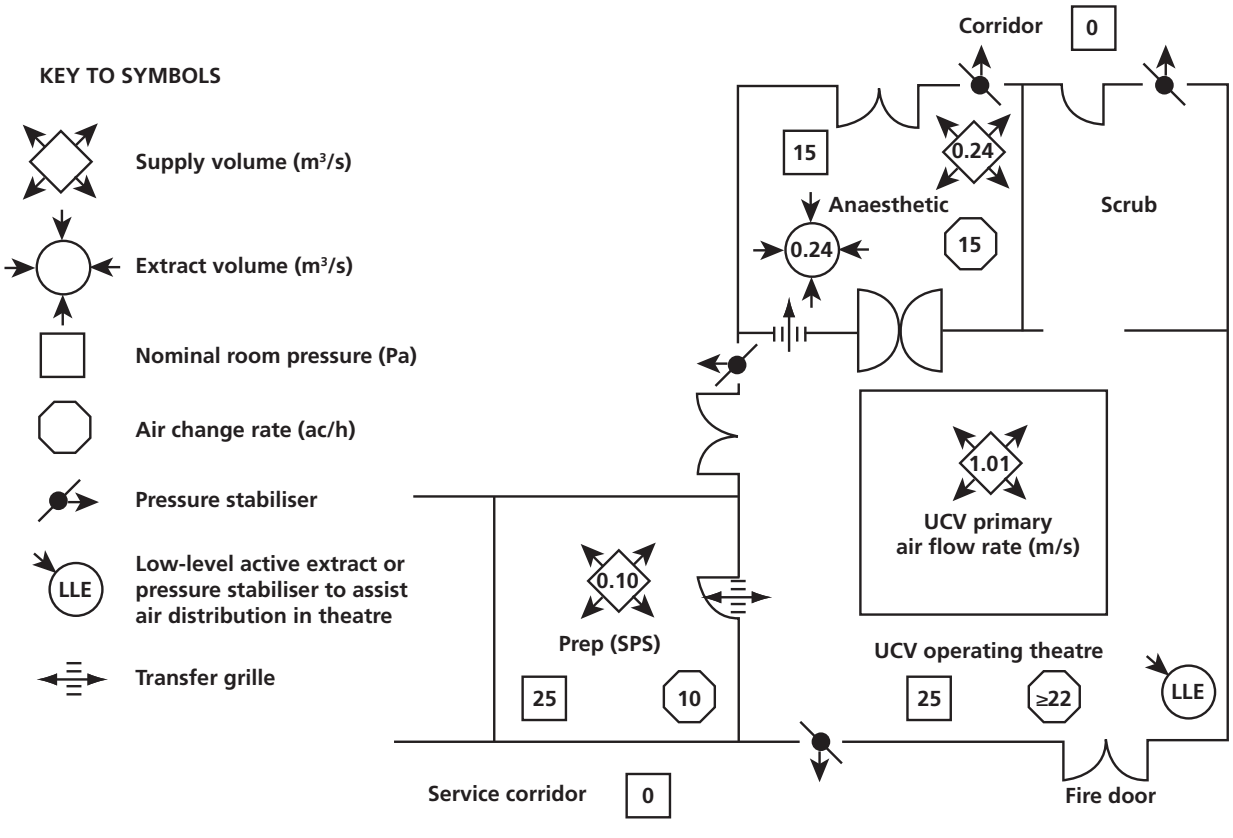
‡ Derived from Health Building Note 10-01 (2021). If room sizes differ from those given, recalculate the design air flows to achieve the air change rate or door protection.

* This is a separate scrub and is not considered as being part of theatre volume.

Primary fresh-air volume to UCV canopy only or ≥22 or door protection

The volume of air to be extracted from the theatre should be determined by subtracting the airflow required for door protection at the key door from the total air entering the space. The balance should be equally divided between the passive or active extract locations.

The extracts within the theatre and scrub may be either passive and fitted with pressure stabilisers or active and connected to the extract system. They should where possible be located at low level and positioned to promote the active ventilation and scouring of all areas of the space (see paragraph 8.92). Air transfer from theatre to anaesthetic room may be by pressure stabiliser or transfer grilles (see paragraphs A8.51 and A8.52 in Appendix 8). The anaesthetic room extract will be at low level (see Appendix 9).



Standard layout 3 – single-corridor conventional operating suite with "lay-up" prep

Room	Size (m^3)‡	Air-change rate (ac/h)	Nominal pressure (Pa)	Flow rate (m^3/s)
Theatre	165	≥22	25	Primary = 0.73 From Prep = 0.28 Total = 1.01
Anaesthetic	57	15	Design 15 Commissioned ≥10	0.24
Lay-up prep	36	≥22	35	0.35**
Scrub	*	–	25	–
Utility	36	–	–5	0.40

Notes:

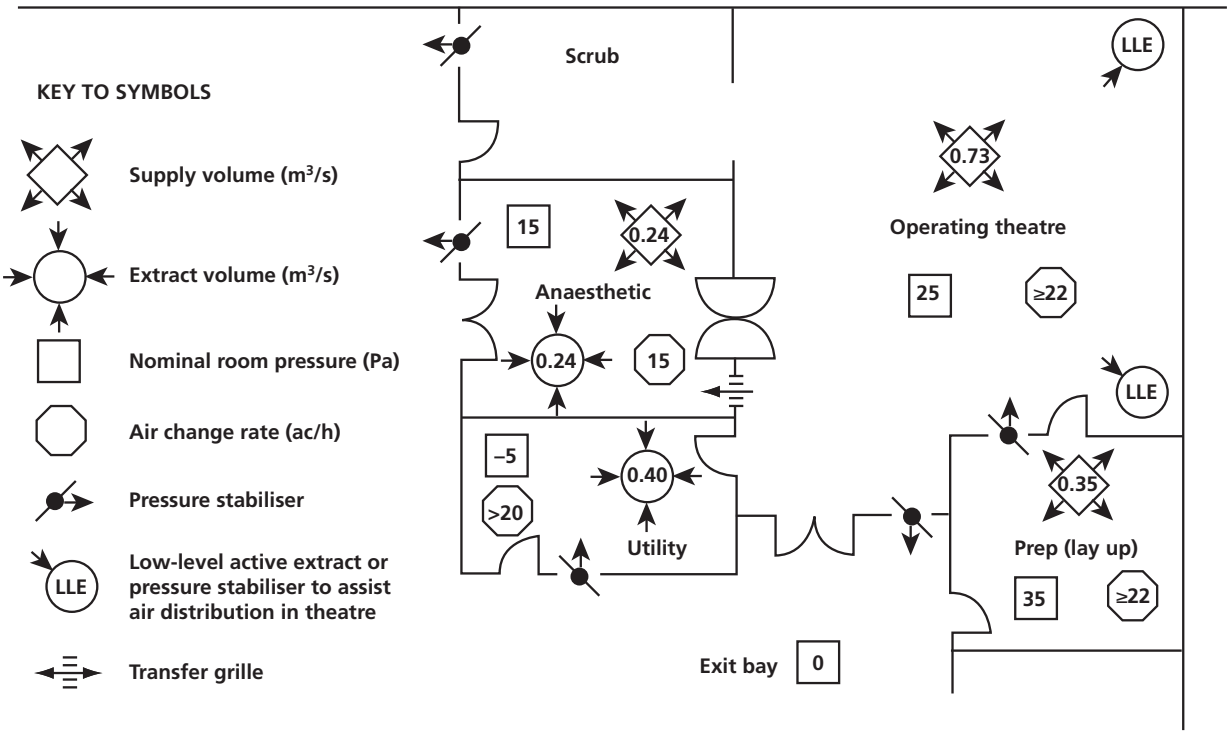
‡ Derived from Health Building Note 10-01 (2021). If room sizes differ from those given, recalculate the design air flows to achieve the air change rate or door protection.

* This is a separate scrub and is not considered as being part of the theatre volume.

** Interchange is not permitted between the theatre and lay-up prep; therefore, as in Appendix 5, an airflow protection of 0.28 + 0.07 closed-door airflow is required as a minimum (but see also the "designers' notes" in Appendix 4).

The volume of air to be extracted from the theatre should be determined by subtracting the airflow required for protection at the key door from the total air entering the space. The balance should be equally divided between the passive or active extract locations.

The extracts within the theatre and scrub may be either passive and fitted with pressure stabilisers or active and connected to the extract system. They should where possible be located at low level and positioned to promote the active ventilation and scouring of all areas of the space (see paragraph 8.92). Air transfer from theatre to anaesthetic room may be by pressure stabiliser or transfer grilles (see paragraphs A8.51 and A8.52 in Appendix 8). The anaesthetic room extract will be at low level (see Appendix 9).



Standard layout 4 – single-corridor UCV operating suite with SPS prep

Room	Size (m^3)‡	Air-change rate (ac/h)	Nominal pressure (Pa)	Flow rate (m^3/s)
Theatre	165	≥22	25	#1.01
Anaesthetic	57	15	Design 15 Commissioned ≥10	0.24
Sterile pack store prep	36	10	25	0.10
Scrub	*	–	25	–
Utility	36	–	–5	0.4

Notes:

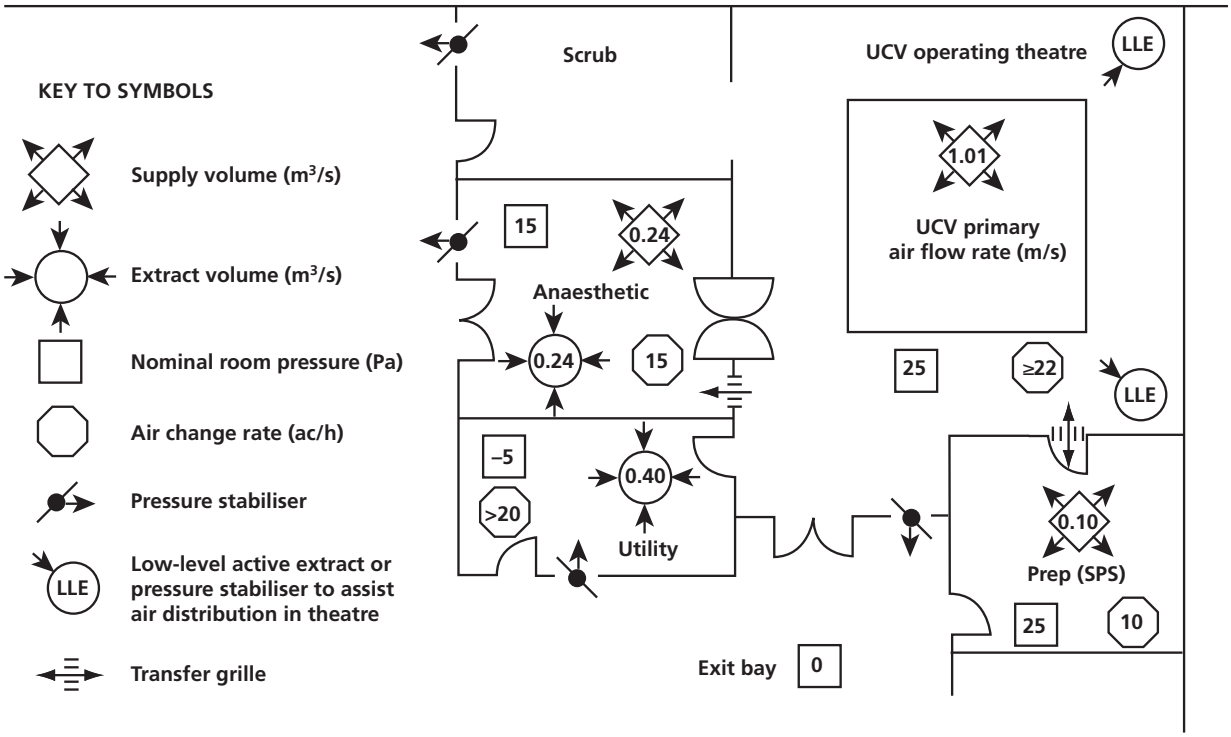
‡ Derived from Health Building Note 10-01 (2021). If room sizes differ from those given, recalculate the design air flows to achieve the air change rate or door protection.

* This is a separate scrub and is not considered as being part of the theatre volume.

Primary fresh-air volume for the UCV canopy or ≥22 ac/h or door protection

The volume of air to be extracted from the theatre should be determined by subtracting the airflow required for protection at the key door from the total air entering the theatre space. The balance should be equally divided between the passive or active extract locations.

The extracts within the theatre and scrub may be either passive and fitted with pressure stabilisers or active and connected to the extract system. They should where possible be located at low level and positioned to promote the active ventilation and scouring of all areas of the space (see paragraph 8.92). Air transfer from theatre to anaesthetic room may be by pressure stabiliser or transfer grilles (see paragraphs A8.51 and A8.52 in Appendix 8). The anaesthetic room extract will be at low level (see Appendix 9).



Standard layout 5 – (ex HTM 2025 Plan 1b): single-corridor conventional operating suite with "lay-up" prep

Note

This layout and data is for historical purposes only. The information is to be used for the evaluation of existing systems, the fitting out of existing shell schemes or rebalancing of such systems following cleaning.

Room	Size	Air-change rate (ac/h)	Nominal pressure (Pa)	Flow rate (m^3/s)
Theatre	Existing theatre suite rooms to be measured on site	≥22	25	# See Notes below
Anaesthetic		15	Design 15 Commissioned ≥10	~ Supply and extract to achieve the air change rate
Lay-up prep		≥22	35	0.35*
Scrub		–	25	–
Utility		>20	–5	0.40

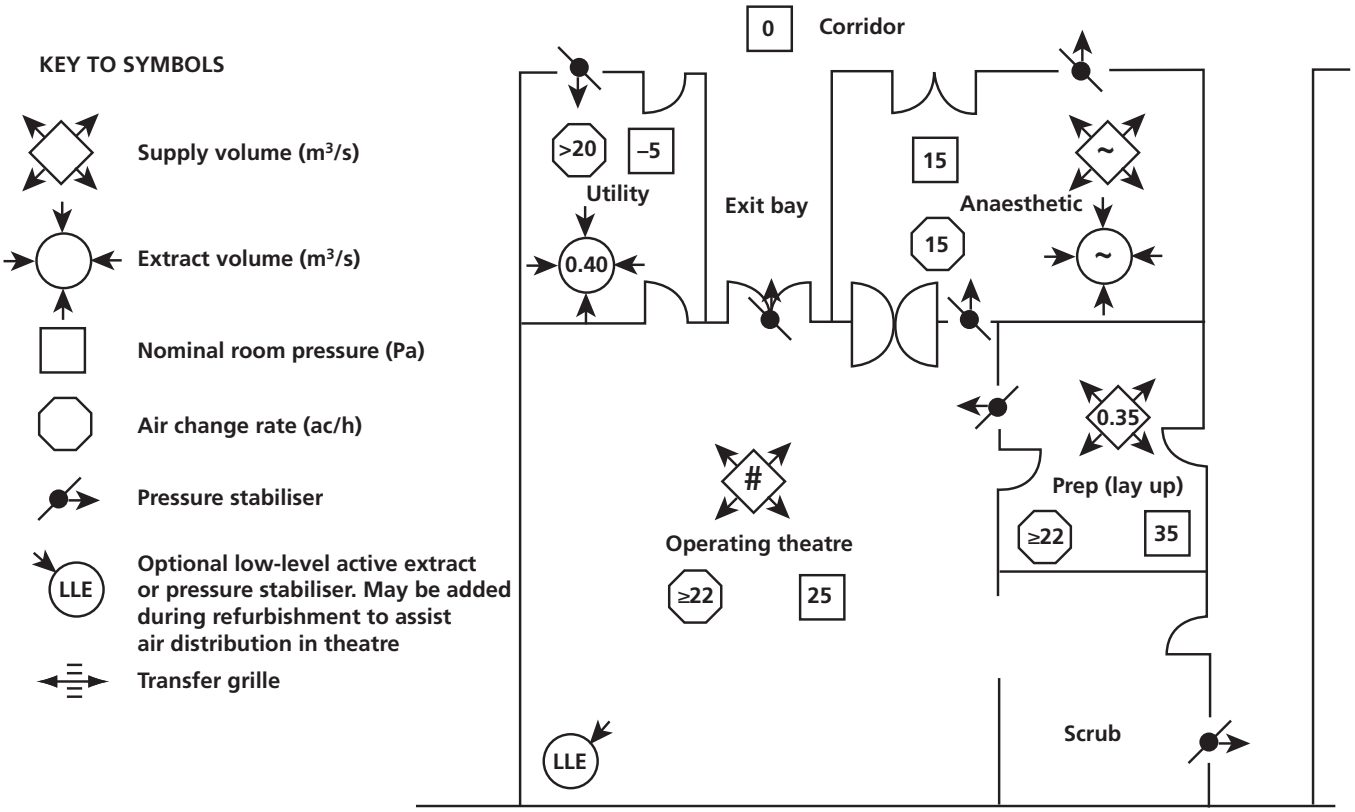
Notes:

Total airflow related to volume of theatre to give ≥22 ac/h **or** door protection value = primary theatre supply + 0.28 m^3/s from the Lay-up Prep pressure stabiliser

* See the "designers' notes" in Appendices 4 and 5.

The utility layout design figures will remain the same if a hatch is fitted instead of a door onto the service corridor.

The extracts within the theatre and scrub may be either passive and fitted with pressure stabilisers or active and connected to the extract system. They should where possible be located at low level and positioned to promote the active ventilation and scouring of all areas of the space (see paragraph 8.92). Air transfer from theatre to anaesthetic room may be by pressure stabiliser or transfer grilles (see paragraphs A8.51 and A8.52 in Appendix 8). The anaesthetic room extract will be at low level (see Appendix 9).



Standard layout 6 – (ex HTM 2025 Plan 1a): single-corridor UCV operating suite with SPS prep

Note

This layout and data is for historical purposes only. The information is to be used for the evaluation of existing systems, the fitting out of existing shell schemes or rebalancing of such systems following cleaning.

If difficulties are experienced with entrainment around the periphery of the UCV, adding a low-level active or passive extract in the location indicated will usually resolve the problem.

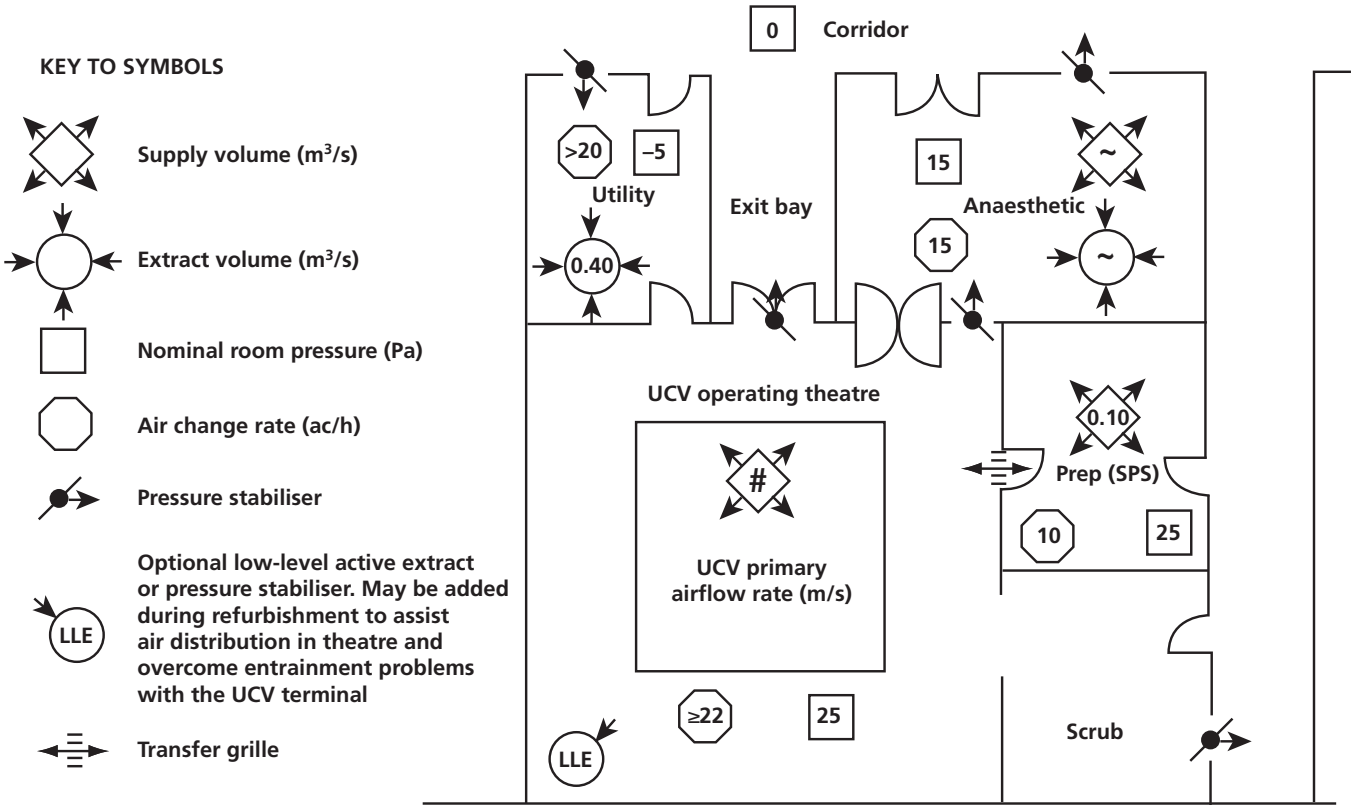
Room	Size	Air-change rate (ac/h)	Nominal pressure (Pa)	Flow rate (m³/s)
Theatre	Existing theatre suite to be measured on site	≥22	25	# See Notes below
Anaesthetic		15	Design 15 Commissioned ≥10	~ Supply and extract to achieve the air change rate
Sterile pack store prep		10	25	0.1
Scrub		–	25	–
Utility		–	–5	0.4

Notes:

Theatre total airflow related to volume of theatre to give ≥22 ac/h or door protection value

The utility layout design figures will remain the same if a hatch is fitted instead of a door onto the service corridor.

The extracts within the theatre and scrub may be either passive and fitted with pressure stabilisers or active and connected to the extract system. They should where possible be located at low level and positioned to promote the active ventilation and scouring of all areas of the space (see paragraph 8.92). Air transfer from theatre to anaesthetic room may be by pressure stabiliser or transfer grilles (see paragraphs A8.51 and A8.52 in Appendix 8). The anaesthetic room extract will be at low level (see Appendix 9).



Standard layout 7 – (ex HTM 2025 Plan 5b): two-corridor conventional operating suite with "lay-up" prep

Note

This layout and data is for historical purposes only. The information is to be used for the evaluation of existing systems, the fitting out of existing shell schemes or rebalancing of such systems following cleaning.

Room	Size	Air-change rate (ac/h)	Nominal pressure (Pa)	Flow rate (m^3/s)
Theatre	Existing theatre suite to be measured on site	≥22	25	# See Notes below
Anaesthetic		15	Design 15 Commissioned ≥10	~ Supply and extract to achieve the air change rate
Lay-up prep		≥22	35	0.35*
Scrub		–	25	–
Utility		–	0	0.1

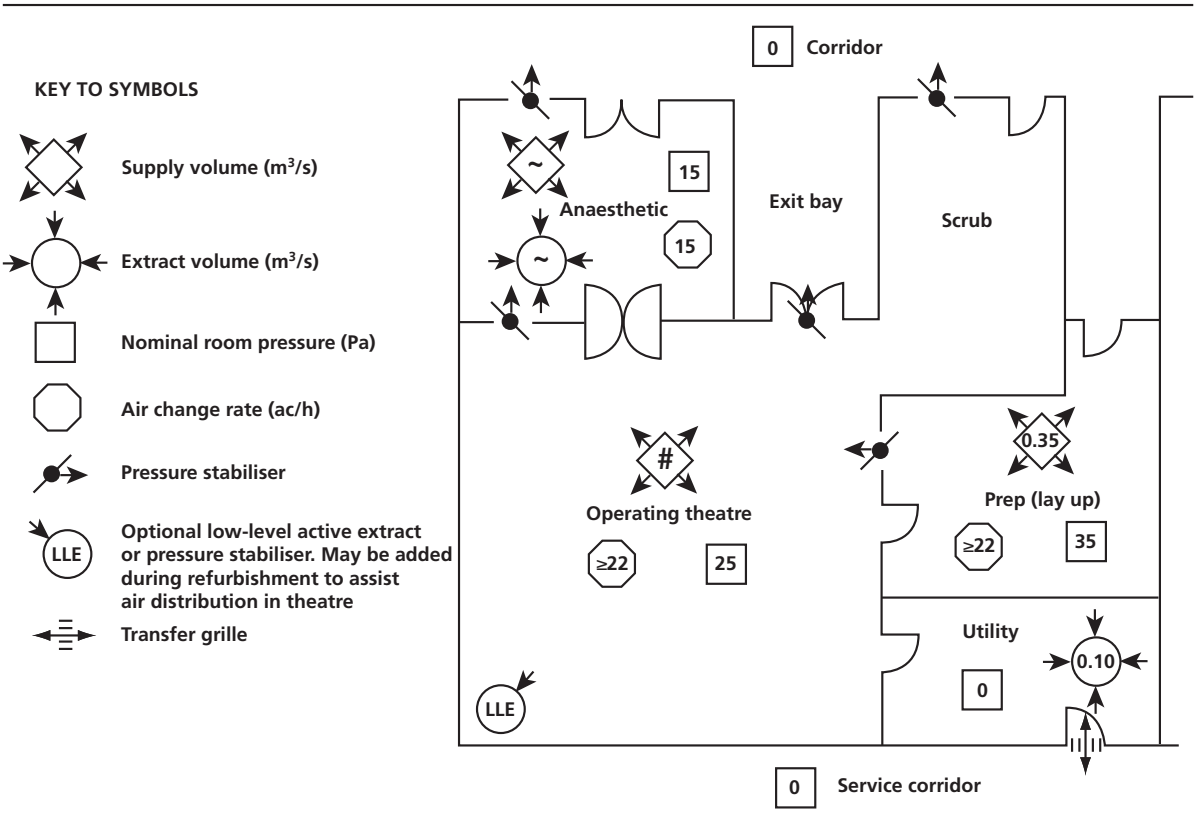
Notes:

Theatre total airflow related to volume of theatre to give ≥22 ac/h or door protection = primary theatre supply + 0.28 m^3/s from Lay-up Prep pressure stabiliser

* See the "designers' notes" in Appendices 4 and 5

The utility design figures will remain the same if a hatch is fitted instead of a door onto the service corridor. Alternatively if the operating department has a central waste processing station, the utility room may be omitted and replaced with a hatch between the theatre and service corridor.

The extracts within the theatre and scrub may be either passive and fitted with pressure stabilisers or active and connected to the extract system. They should where possible be located at low level and positioned to promote the active ventilation and scouring of all areas of the space (see paragraph 8.92). Air transfer from theatre to anaesthetic room may be by pressure stabiliser or transfer grilles (see paragraphs A8.51 and A8.52 in Appendix 8). The anaesthetic room extract will be at low level (see Appendix 9).



Standard layout 8 – (ex HTM 2025 Plan 5a): two-corridor UCV operating suite with SPS prep

Note

This layout and data is for historical purposes only. The information is to be used for the evaluation of existing systems, the fitting out of existing shell schemes or rebalancing of such systems following cleaning.

If difficulties are experienced with entrainment around the periphery of the UCV, adding a low-level active or passive extract in the location indicated will usually resolve the problem.

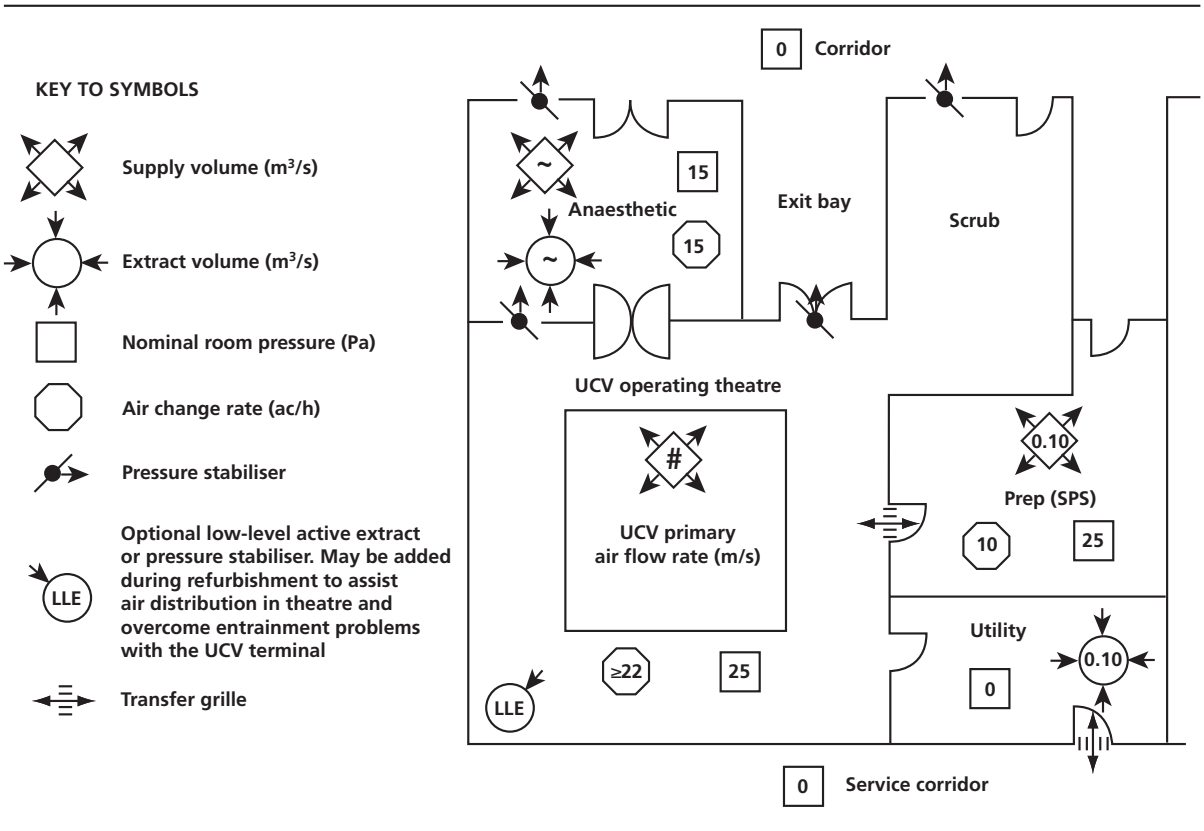
Room	Size	Air-change rate (ac/h)	Nominal pressure (Pa)	Flow rate (m^3/s)
Theatre	Existing theatre suite to be measured on site	≥22	25	# See Notes below
Anaesthetic		15	Design 15 Commissioned ≥10	~ Supply and extract to achieve the air change rate
Sterile pack store prep		10	25	0.1
Scrub		–	25	–
Utility		–	0	0.1

Notes:

Primary fresh supply air for the UCV canopy is related to volume of theatre to give ≥22 ac/h or door protection

The utility design figures will remain the same if a hatch is fitted instead of a door onto the service corridor. Alternatively if the operating department has a central waste processing station, the utility room may be omitted and replaced with a hatch between the theatre and service corridor.

The extracts within the theatre and scrub may be either passive and fitted with pressure stabilisers or active and connected to the extract system. They should where possible be located at low level and positioned to promote the active ventilation and scouring of all areas of the space (see paragraph 8.92). Air transfer from theatre to anaesthetic room may be by pressure stabiliser or transfer grilles (see paragraphs A8.51 and A8.52 in Appendix 8). The anaesthetic room extract will be at low level (see Appendix 9).



Appendix 8: Design of air-movement control schemes for operating theatres

General

A8.1 Standard operating suite design solutions are given in paragraphs 8.27–8.74 and Appendix 7. If these standard solutions cannot be used, the following procedure should be adopted, which will result in an acceptable design. Note that the method employed may equally be used to provide a design solution to a ventilated suite of rooms for any application.

A8.2 The method is concerned with the calculation of air-flow rates to ensure that correct air movement occurs between rooms when any one door is open. Under most circumstances, the air quantities required for air-movement control will approximate to those for either temperature control or bacterial contaminant dilution. This flow rate is sufficient to control the effects of any slight reverse flows occurring when a door is opened.

A8.3 The progression through the design procedure is shown in the air-flow design procedure chart (Figure A7) and is supported by worksheets WS1 to WS7 described in paragraph A8.4. It is recommended that a plan of the suite and an air-flow network be made (Figure A6) to collate all information. Flow rates, air-transfer devices etc should be entered as required. The remainder of this Appendix may be treated as reference data to assist in the various steps. The following symbols are used:

S_S – supply air-flow rate for summer temperature control;

S_W – supply air-flow rate for winter temperature control;

S_D – supply air-flow rate for dilution of bacterial contaminants;

S_L – supply air-flow rate for heat loss;

S_G – supply air-flow rate for heat gain;

E_D – extract air-flow rate for dilution of bacterial contaminants;

S_F – final supply air-flow rates

E_F – final extract flow rates;

S_{AMC} – air-supply flow rate for air-movement control;

E_{AMC} – air-extract flow for air-movement control;

L_{OUT} – leakage air-flow rate outward;

L_{IN} – leakage air-flow rate inward;

$\sum_{OUT}$ – total air-flow rate outward;

$\sum_{IN}$ – total air-flow rate inward.

A8.4 To simplify the procedure, standard worksheets (WS1 to WS7) have been devised. For each operating suite, a set is required comprising one each of WS1, WS3, WS5, WS6a, WS6b and WS7, one WS4 for each corridor and one WS2 to cover each peripheral room. WS2 has five versions:

- WS2a single flow,
- WS2b parallel/series multi-flow,
- WS2c parallel multi-flow or series multi-flow (unbalanced);
- WS2d series multi-flow (balanced); and
- WS2e bay (semi-open).

Peripheral room type

A8.5 The rooms in the operating suite other than the operating theatre and corridor are referred to as peripheral rooms. Peripheral rooms have been classified according to the flows in and out. These room classifications are defined in paragraphs A8.6–A8.11.

Single flow

A8.6 This is a room with only one door and a net surplus of supply or extract air.

Parallel multi-flow

A8.7 This is a room with two or more doors through each of which the air flows either outwards (high pressure) or inwards (low pressure) (for example the Prep (lay-up) in standard layout 5 in Appendix 7).

Parallel/series multi-flow

A8.8 This is a room having a net surplus of supply or extract and with two or more doors. One or more doors will be to an area of equal cleanliness and need not be protected; hence, the flow may vary between inwards and outwards, the remaining door being to an area of greater or lesser cleanliness (for example the Prep (SPS) in standard layout 6 in Appendix 7).

Series multi-flow (unbalanced)

A8.9 This is a room having a net surplus of supply or extract and with two or more doors. Air flows inwards through one or more doors and outwards through one or more doors.

Series multi-flow (balanced)

A8.10 This is a room as in paragraph A8.9 above, but having either no mechanical ventilation or no net surplus of supply or extract (for example an anaesthetic room).

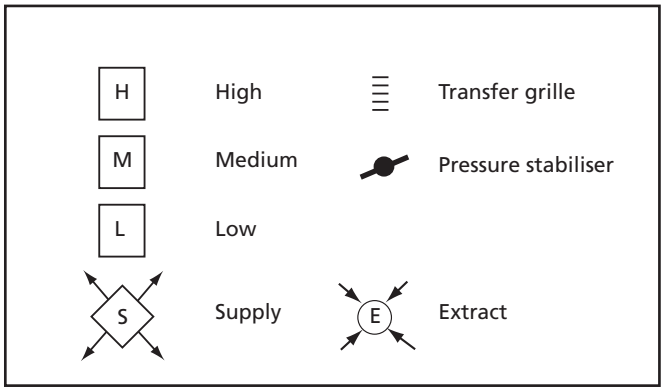
Bay

A8.11 A room which has a permanent opening to the operating theatre may be considered as a bay off the latter (for example a scrub). Two categories exist:

- open bay – the opening is larger than a normal single door opening. The bay may be considered as part of the main room;
- semi-open bay – the opening is no larger than a normal single door opening. In this case it is possible to protect the bay from the main room by provision of air supply or extract in the bay, or by passing air to or from another area.

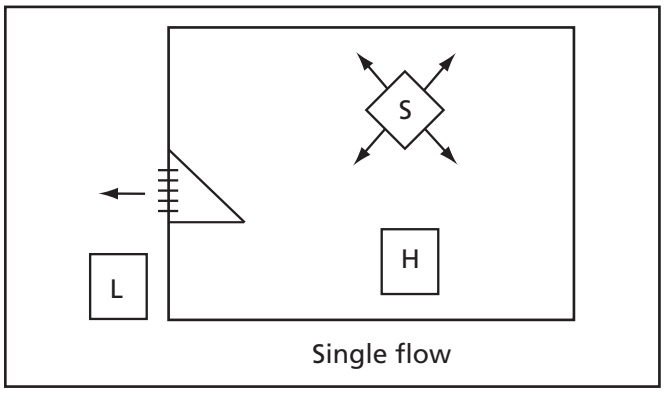
Air-movement control in peripheral rooms

A8.12 For the design of air-movement control, two types of air-transfer device are considered. These are transfer grilles and pressure stabilisers. Each has a particular field of application within the design, as described in paragraphs A8.34–A8.43. Air movement is controlled in each of the different room types described in paragraphs A8.13–A8.31.



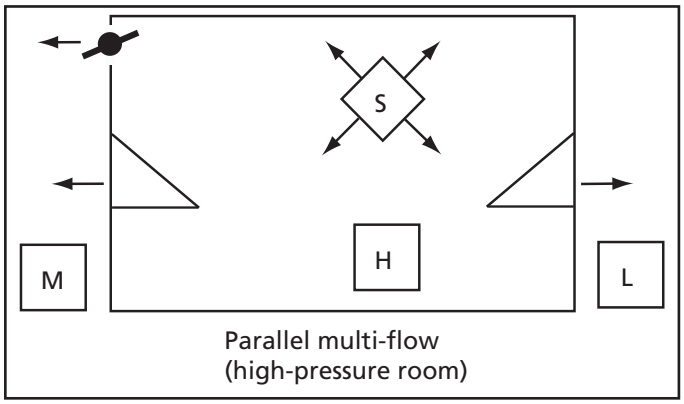
Single flow rooms

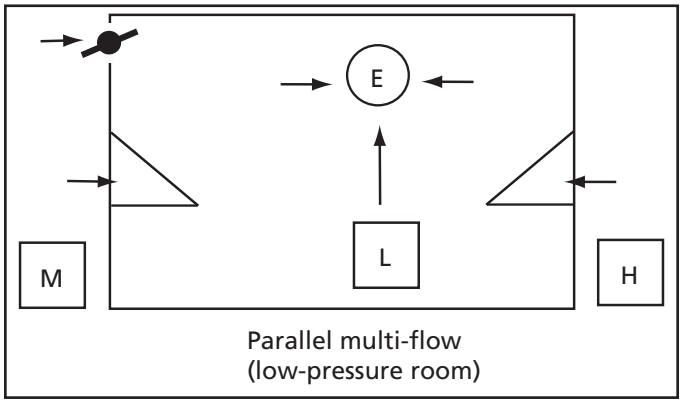
A8.13 An appropriately-sized transfer grille should be located in or adjacent to the door of each single flow room to relieve the pressure differences across the door when closed.



Parallel multi-flow rooms

A8.14 The pressure difference across the closed doors should be relieved, but transfer grilles are not appropriate where two doors lead to areas of different pressures, because reverse flow could occur when the other door is open. For this reason, pressure stabilisers are used.



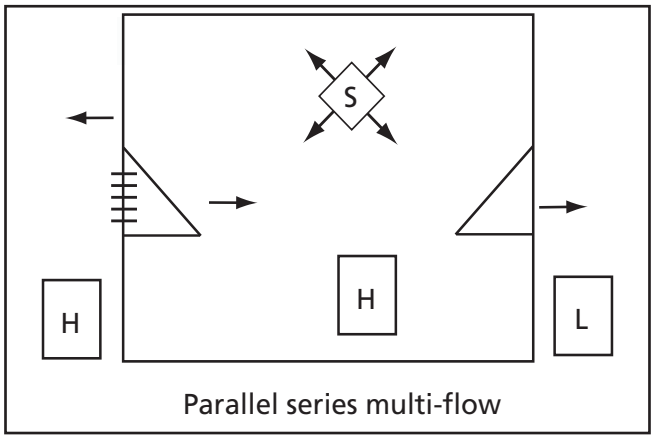


A8.15 These rooms will be either high-pressure or low-pressure with respect to the adjacent areas (see preparation lay-up room and disposal room, respectively, in standard layout 5 of Appendix 7). The pressure-relief damper is always situated between the room and area, which results in the smaller differential pressure to ensure best use of air.

A8.16 Just as reverse flow can occur if transfer grilles are used, it can similarly occur via door gaps when the other door is opened. It is not possible to avoid this, except by using air locks, but due to the low flow rates and short durations involved, this is not considered to be of importance.

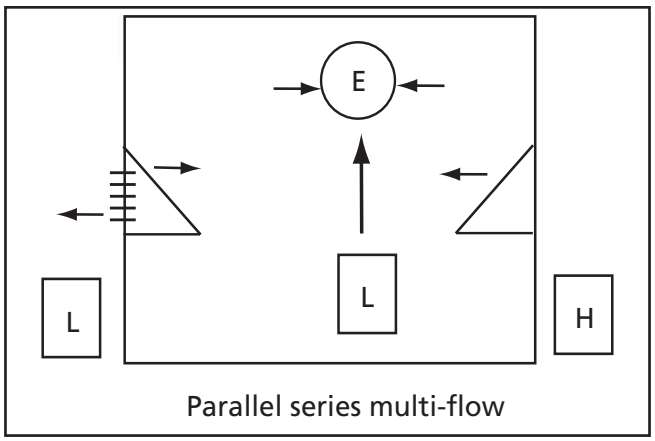
Parallel-series multi-flow rooms

A8.17 These rooms are similar to those in paragraph A8.14 above, but because the room is of equal cleanliness to one of the adjacent rooms, the nominal pressures will be equal and air may flow through the adjoining doorway in either direction (for example the Prep (SPS) in standard layout 6 of Appendix 7).



Parallel series multi-flow

A8.18 Where the nominal room pressure equals that of the higher-pressure adjacent room, the best use of air is by supplying air required for bacterial dilution only and allowing this to exhaust via a transfer grille to the area of equal cleanliness. The doorway to the lower pressure area is protected by the combination of the supply air and the air that will flow inwards through the transfer grille from the area of equal cleanliness.

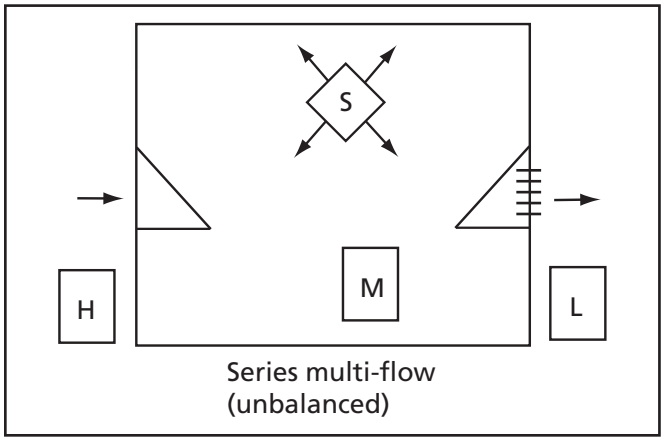


Parallel series multi-flow

A8.19 Conversely, where the nominal pressure equals that of the lower-pressure adjacent room, extract ventilation and a transfer grille to the lower pressure adjacent room should be provided (for example the disposal room in standard layout 8 of Appendix 7).

Series multi-flow (unbalanced)

A8.20 These rooms are somewhat similar to those in paragraph A8.15 above, but because the pressure lies between that of the rooms on either side, the back-flow problem does not exist.



Series multi-flow
(unbalanced)

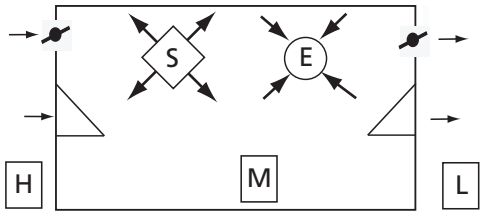
A8.21 Where the room has a net surplus of mechanical supply air, a transfer grille should be located in or adjacent to the door through which air flows outwards, and the mechanical supply flow rate to the room should be chosen to give protection when this door is open.

A8.22 Where the room has a net surplus of mechanical extract air, a transfer grille should be located adjacent to the door through which the air flows inwards, and the mechanical extract flow rate to the room should be chosen to give protection when this door is open.

A8.23 The grille should be sized for the protection requirement of the opposing door when open. When the room on the high-pressure side depressurises, there is a possibility of back-flow through gaps around the door, but this problem may be ignored.

Series multi-flow (balanced)

A8.24 In these rooms, a transfer device adjacent to each doorway is required in order to provide a flow path for the air required to protect the opposing door when opened.



Series multi-flow

A8.25 These transfer devices will normally be pressure stabilisers, although transfer grilles may be used where a large amount of excess air is to be exhausted from the operating theatre when all doors are closed (for example anaesthetic rooms).

A8.26 The calculation procedure is to assume that pressure stabilisers are being used; then – if there is sufficient excess air – change to transfer grilles as described in paragraph A8.50.

Bay

Open bay

A8.27 A bay of the open type (for example scrub-up) is considered to be part of the operating theatre. There should be an active or passive extract/pressure stabiliser under, or directly adjacent to, the scrub trough.

Semi-open bay

A8.28 In a bay of the semi-open type, protection of one area from the other is possible (for example scrub-up).

A8.29 As stated previously, the need for protection between operating theatre and scrub-room is not very great. Better use of air can therefore be achieved in this case by installing a pressure stabiliser between the scrub-room and clean corridor. This will allow a flow of air through the scrub-room at all times, except when a door is opened elsewhere in the suite. The pressure stabiliser will then close and the air will be diverted to the other door. When it is considered necessary to protect the scrub-room at all times, either a transfer grille to the corridor or mechanical extract in the scrub-room should be provided.

Operating theatre

A8.30 Once the peripheral rooms have been considered, the operating theatre requirements may then be decided and the supply flow rate required for air-movement control calculated. This flow rate should be such that, with any one door open, the correct air movement directions are maintained. There will be one door in the suite that will require the largest supply flow rate to the operating theatre for protection when open. This is called the "key door" and is discussed separately in paragraph A8.33. Use of this concept avoids repetitive calculations for each door in turn. Having established the required supply flow rate, a relief route should be provided to the clean corridor for any excess air when the doors are closed. This would be via transfer grilles or pressure stabilisers through a series-flow room or via pressure stabilisers to the clean corridor directly.

Corridors

A8.31 All surplus air from the suite, except that lost through structure leakage and any passing to the outer corridor, will arrive in the patient/staff corridor. Should this air be insufficient to achieve the required air-change rate (see Appendix 3), some additional air supply should be provided. (The air balance should take account of structural leakage.)

Door opening

A8.32 Whereas the resulting pressures are dependent on ductwork layout, room relationships and characteristics of the fan, the generalisations shown in Appendix 6 may be used to estimate the change in room pressure when a door is opened.

A8.33 The "key door" will be the open double door which leaves the operating theatre at the highest pressure, and/or requires the largest air flow. This should be determined using the procedure in worksheet WS3.

Transfer grilles

A8.34 These may be used to limit the pressure differences across the closed door of a single-flow room or, in some instances, for protection of a series-flow or parallel-series-flow room. They allow air flow in both directions and may not be suitable for all applications.

A8.35 The free area of a grille is calculated from the following equation:

$$A = \frac{Q}{0.84\sqrt{\Delta P}}$$

where:

A is free area (m^2)

Q is flow rate (m^3/s)

P is pressure difference (Pa)

0.84 is the grille's resistance-correction factor.

A8.36 The flow through a grille at a different pressure may be found from the following equation:

$$Q_2 = Q_1\sqrt{\frac{\Delta P_1}{\Delta P_2}}$$

where:

Q_1 and P_1 are original flow and differential pressure

Q_2 and P_2 are new flow and differential pressure.

A8.37 The transfer grille may be replaced by carefully proportioned door undercuts of the equivalent free area.

A8.38 The function of the transfer grille is to provide a means of air-flow control by which the volume and pressure loss can be established. If a grille is used, it should have an easily removable core to facilitate cleaning.

Pressure-relief dampers

A8.39 The functions of a pressure-relief damper are now carried out by pressure stabilisers. Accordingly, all mention of them has been removed from this document.

Pressure stabilisers

A8.40 Pressure stabilisers can be adjusted to hold the pressure constant over a wide range of flow rates. They are used where requirements exist for accurate room-pressure control or rapid shut-off on pressure fall.

A8.41 The installation of a grille or baffle in association with a stabiliser will alter the operating characteristics. It is recommended that a location be chosen to avoid the need for visual screening, for example, at high level. The location should be chosen to minimise the likelihood of damage.

A8.42 The stabilisers used should be virtually silent in operation, adjustable on site, maintenance-free and of a type which cannot be wrongly inserted. They should not be used in external walls or where the pressure difference is less than 5 Pa. The required size of a pressure stabiliser is dependent on the design pressure difference across it and flow rate through it. The manufacturer should provide data relating pressure difference to mean velocity (or flow rate per unit area). From

this, the required area can be calculated and then rounded-up to the nearest size manufactured or nearest combination of smaller sizes.

A8.43 It is sometimes possible to arrange for a pressure stabiliser to perform two tasks. In an anaesthetic room, for example, the two pressure stabilisers may be made to pass the open door protection air, and also control the operating and anaesthetic room pressures with the door closed. To achieve this, the stabilisers are sized for the flow rate required with one of the doors open, but the pressure setting is adjusted to be the value required with the doors closed. This is shown in Figure A5.

Door leakage flows

A8.44 For an air-movement control scheme to work satisfactorily, it is essential that the estimates of door-gap leakage made at the design stage are closely related to those which are achieved in practice. The calculation of gap-flows is complicated by the fact that such flows generally fall into the transition region between laminar and turbulent flow and hence do not follow the normal flow equations. The gaps assumed are 4 mm along the bottom, 3 mm at the top and sides, and 2 mm between double leaves. Doors should not have wider gaps than these. Tighter gaps would result in lower flow-rate requirements and hence lower fan power, but care should be taken to ensure that all doors in the suite have similar gap dimensions. It may be possible to ignore the door leakage and so reduce the air-flow requirement (see the "designers' notes" in Appendix 4).

Room temperature estimation

A8.45 The air-flow rate required to prevent back-flow through an open door is dependent on the temperature difference across the door. The design figures shown in Appendix 6 are based on the temperature differences that will normally occur in practice, assuming heat gains and losses in accordance with Appendix 4.

A8.46 At step 11 of the air-flow design process, the temperature differences across the doors of all rooms classed as "sterile" are calculated. Worksheet WS6 is recommended for the calculations, using the following criteria:

a. assume that the operating theatre is being controlled at 20°C and calculate the incoming air-supply temperature as shown on worksheet WS6;

b. the calculation should be repeated for both summer and winter conditions, with an operation in progress;

c. assume all doors are closed;

d. use the room supply flow rates from WS1;

e. use the inward air flows through air-transfer devices and closed door leakages from WS2a to WS2E;

f. the formula used in worksheet WS6 is as follows:

$$T = \frac{(t_1Q_1 + t_2Q_2 + \ldots + t_nQ_n) + 0.828H}{(Q_1 + Q_2 + \ldots Q_n)}$$

where:

Q = flow rate from source (m^3/s)

t = the temperature of source (°C)

H = the room heat gain (kW).

A8.47 If the evaluated temperature differences between rooms do not exceed 2°C, the solution is satisfactory; otherwise proceed as follows:

(i) check the assumption on which the heat gains are based;

(ii) take steps to reduce the heat gains;

(iii) if the door is to a corridor, the flow through the open door will be larger than the value given in Appendix 6. Calculate on WS3, assuming it is the "key door" with door-flow unknown, and the supply as known;

(iv) if the door leads to a room with mechanical supply, install a trimmer heater in the supply to the room controlled by either a differential thermostat or a thermostat slaved to the operating theatre thermostat to ensure that T is minimised;

(v) if the door leads to a room with no mechanical supply, increase the door protection flow as follows:

$$Q_{new} = Q_{old}\left[\frac{\Delta T + 1}{2}\right]$$

A8.48 These options should be considered in this order, and (i), (ii) and (iii) should be investigated thoroughly before proceeding to (iv) or (v). The mechanical supply may need to be increased in order to achieve the desired air-change rates.

Relief of excess air from operating theatre when all doors are closed

A8.49 As the mechanical supply to the operating theatre is sized to provide an appropriate flow outwards through any door which is opened, it follows that when all doors are closed, there will be more air supplied to the operating theatre than can exit from it via leaks etc. This "excess" air can be relieved by either of the two methods described in paragraphs A8.50–8.54.

By transfer devices via the anaesthetic room

A8.50 The transfer device (pressure stabiliser or transfer grille) between the theatre and anaesthetic room needs to accommodate an air volume of 0.46 m³/s at 20 Pa (see Appendix 6) when the door between the anaesthetic room and corridor is open. An additional 0.11 m³/s will pass through the door gaps of the theatre to anaesthetic door to give a total door flow protection figure of 0.57 m³/s through the open door between the anaesthetic room and corridor. The optimum duty for this device with all the doors closed would be 0.33 m³/s at the room differential of 10 Pa. The following equation shows how this figure is arrived at:

$$Q = \frac{Q_1}{\left(\sqrt{\frac{\Delta P_2}{\Delta P_1}}\right)}$$

$$= \frac{0.46}{\left(\sqrt{\frac{\Delta 20}{\Delta 10}}\right)}$$

$$= 0.33 \text{ m}^3/\text{s}$$

where:

Q = excess air to be vented with doors closed

Q_1 = airflow required for door protection through the transfer device

ΔP_1 = nominal differential pressure with door to operating theatre closed and door to corridor closed

ΔP_2 = nominal differential pressure between the operating theatre and anaesthetic room when the corridor door is open.

A8.51 If the excess air is less than 0.33 m³/s, a pressure stabiliser is required to ensure that the correct pressure and protection airflow is available to pass through the door.

A8.52 If the excess air is greater than 0.33 m^3/s, a transfer grille is acceptable because at all times the airflow will exceed the flow required for pressure and door protection.

By pressure stabilisers to the corridor

A8.53 If it is undesirable to pass all the extra remaining air volume through the anaesthetic room after the door flow-protection volumes have been achieved, it may be passed from the theatre directly to the corridor via a separate pressure stabiliser.

A8.54 If there is sufficient excess air, the transfer grille solution at paragraph A8.52 should be adopted, as it provides the simplest solution and, once set up, will require no further maintenance. With less excess air, it is recommended that the air be passed through the anaesthetic room via the pressure stabilisers as at paragraph A8.51, thus keeping the number of pressure stabilisers to a minimum. Both these solutions increase the air-change rate in the anaesthetic room, but care should be taken to avoid passing excessive amounts through that would cause discomfort to the occupants.

Figure A5 Pressure stabilisers performing two tasks

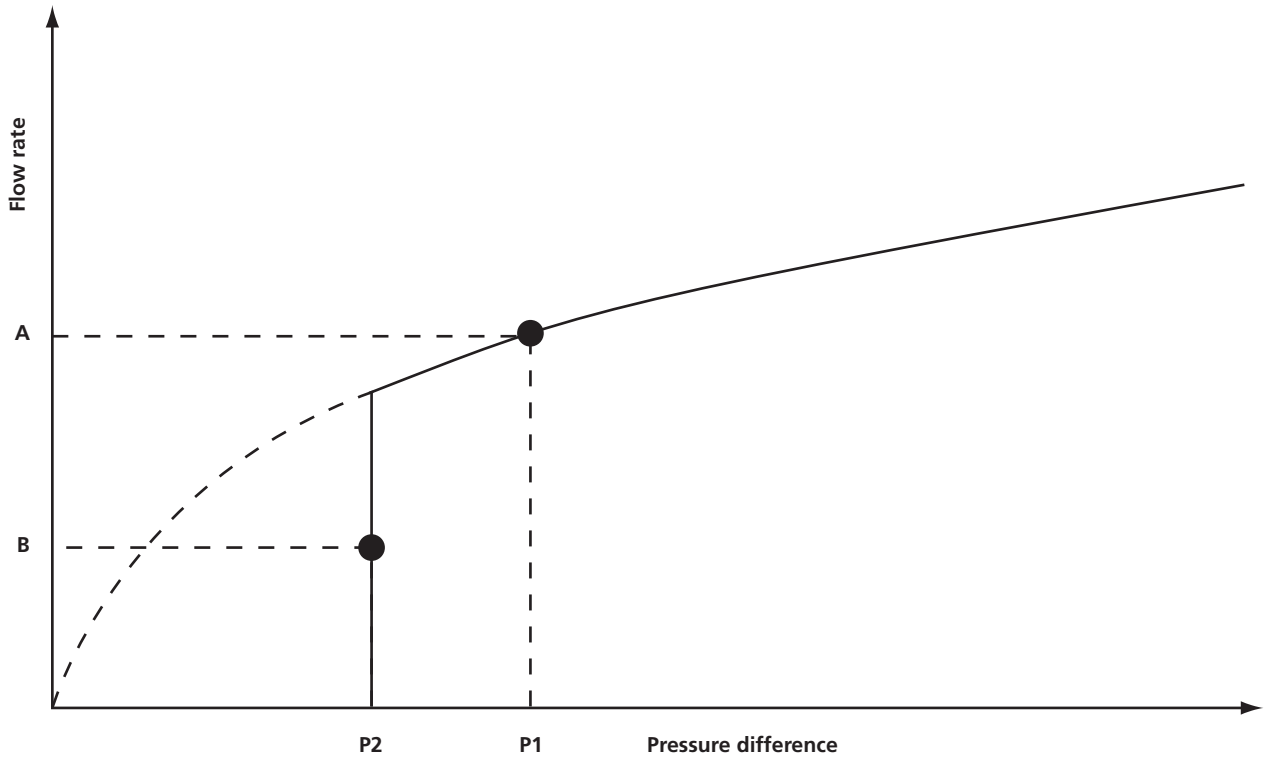


Figure A6 An example of an air-flow network

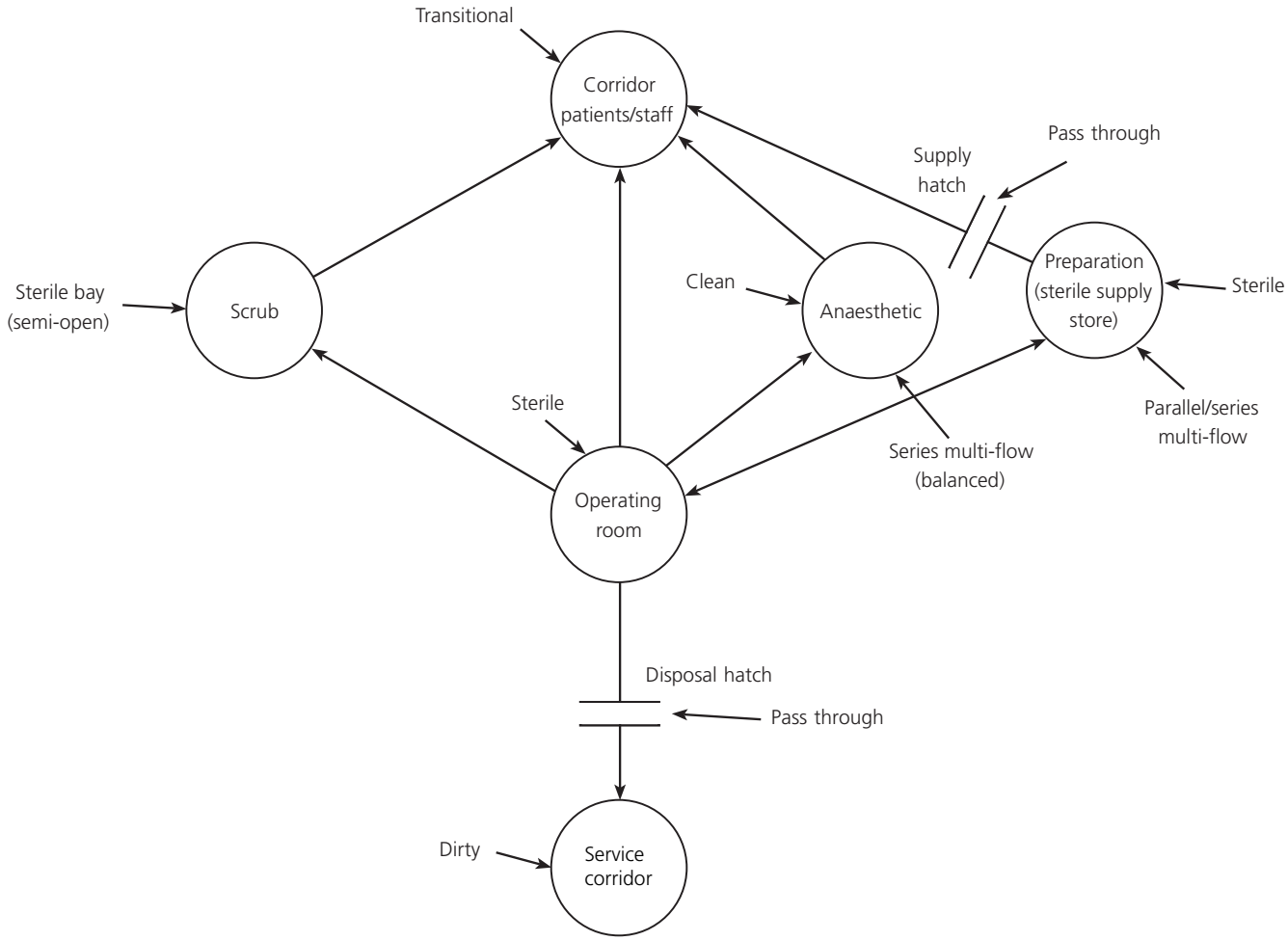
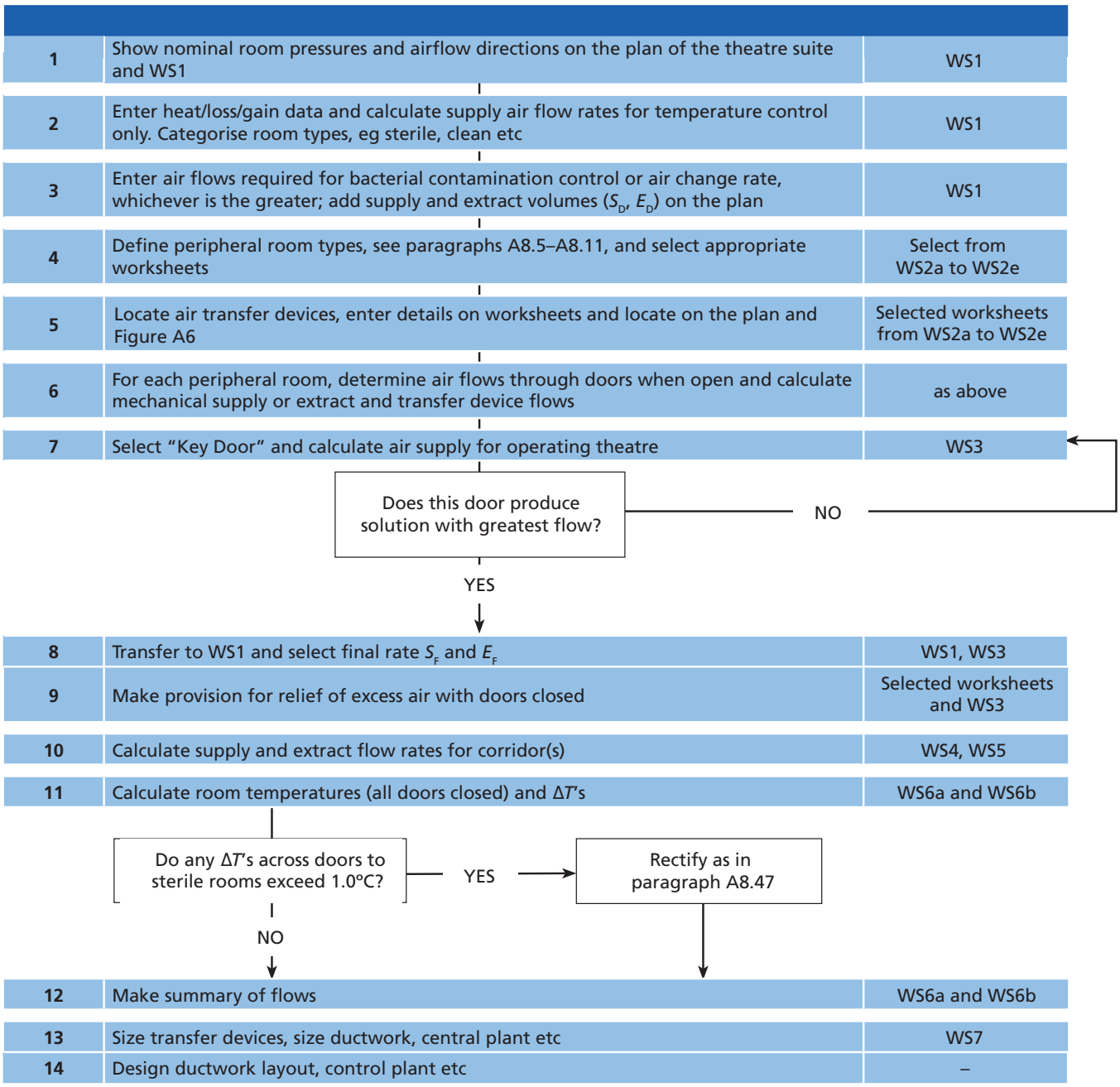


Figure A7 Air-flow design procedures



Calculation sheet for flow rates			**Worksheet WS1** **Reference:**			
Room name						
1. Summer temperature control Heat gain	kW					
2. Acceptable Δt	°C					
3. Air flow rate (S_G) $= \frac{\text{Gain}}{\Delta t \times 1.2}$	m^3/s					
4. Winter temperature control Heat loss	kW					
5. Acceptable Δt	°C					
6. Air flow rate (S_L) $= \frac{\text{Loss}}{\Delta t \times 1.2}$	m^3/s					
7. Dilution of bacterial contaminants Air flow rate S_D or E_D	m^3/s					
8. Desired air change rate $\frac{\text{AC/hr} \times \text{room volume } (m^3)}{3600}$	AC/hr					
	m^3/s					
9. Maximum of S_G, S_L, S_D or E_D or air change rate from step 8	m^3/s					
10. Air movement control Air flow rate for air movement control S_{AMC} or E_{AMC} (from WS2, WS3 or WS4)	S m^3/s					
	E m^3/s					
11. Final supply flow rate (S_F)	m^3/s					
12. Final extract	m^3/s					
13. Total supply		m^3/s				
14. Total extract		m^3/s				

Designer ..... Date .....

Air movement control **Peripheral room ..... type, single flow**	**Worksheet WS2a** **Reference:** **Nominal pressure:** **Pa**

Consider door to ..... open

			Air flow, m^3/s		
	Pa	Δt	Out	In	Remarks
Flow required through doorway to give protection					
Total					

S_{AMC} $(\sum_{OUT} - \sum_{IN})$ ☐ m^3/s

or

E_{AMC} $(\sum_{IN} - \sum_{OUT})$ ☐ m^3/s

Transfer S_{AMC} or E_{AMC} to WS1

Consider door to ..... closed

	Pa	Δt	Out	In	Remarks
Closed door leakage					
Total					

Return S_F and E_F to WS1 ☐ ☐

Flow through transfer grille outward $(S_F - E_F - L_{OUT})$ ☐

or

Flow through transfer grille inward $(E_F - S_F - L_{IN})$ ☐

Designer ..... Date .....

Air movement control **Peripheral room ..... type, parallel/series multi-flow**	**Worksheet WS2b** **Reference:** **Nominal pressure:** **Pa**

Door from this room to ..... (room of equal cleanliness) is not to be protected.
A transfer grille is located in, or adjacent to, this door

Consider other door to ..... open.

Room pressure now becomes [ ] or [ ] or [ ] Pa (see Appendix 6)

			Air flow, m^3/s		
			Out	In	Remarks
Flow required through doorway to give protection					
At above pressures leaks through closed doors	Pa	ΔP			
Mechanical supply or extract (S_F/E_F)					
		Total			

X ($\sum_{OUT} - \sum_{IN}$) [ ] or Y ($\sum_{IN} - \sum_{OUT}$) [ ]

Transfer grille required
from high-pressure zone Flow = X
or [ ] at [ ] ΔPa
to low-pressure zone Flow = Y
Size of transfer grille (free area) A1 [ ]

Consider doors and hatch closed – room presssure becomes [ ] Pa (nominal)

Closed door leakage from Appendix 4 (assuming no transfer grille)	Pa	ΔP	Out	In	Remarks
Mechanical supply or extract					
		Total			

Air flow required through transfer grille = IN – OUT = Z' [ ]
or OUT – IN = Z'' [ ]

Transfer grille required flow Z' or Z'' [ ] @ [ ] ΔP

Size of transfer grille (free area) A2 = [ ]

Select larger of A1 or A2 [ ]

Designer ..... Date .....

Air movement control **Peripheral room ..... type, parallel multi-flow high/low or series multi-flow (unbalanced)**	**Worksheet WS2c** **Reference:** **Nominal pressure:** **Pa**

Consider door from this room to ..... open.

Room pressure now becomes [ ] or [ ] or [ ] Pa (see Appendix 6)

			Air flow, m³/s		
			Out	In	Remarks
Flow required through open doorway to give protection					
At above pressures leaks through closed doors are:	Pa	ΔP			
		Total			

S_1 ($\sum_{OUT} - \sum_{IN}$) [ ] or E_1 ($\sum_{IN} - \sum_{OUT}$) [ ]

Consider door from this room to ..... open.

Room pressure now becomes [ ] or [ ] or [ ] Pa

			Out	In	Remarks
Flow required through open doorway to give protection					
At above pressures leaks through closed doors are:	Pa	ΔP			
		Total			

S_2 ($\sum_{OUT} - \sum_{IN}$) [ ] or E_2 ($\sum_{IN} - \sum_{OUT}$) [ ]

Consider doors closed. Closed doors leakage from Appendix 4

Door to:	Pa	ΔP	Out	In	Remarks
		Total			

Return S_F and E_F from WS1 [ ]

Flow through transfer device outward ($S_F - L_{OUT}$) [ ] to .....

or

Flow through transfer device inward ($E_F - L_{IN}$) [ ] from .....

Transfer grille [ ] Pressure relief damper [ ]

Designer ..... Date .....

Air movement control **Peripheral room ..... type, series multi-flow (balanced)**	**Worksheet WS2d** **Reference:** **Nominal pressure:** **Pa**

Note: In this type of room the supply and extract air flow rates are equal and take no part in the air movement control (AMC)

First, open door to higher pressure area.

Room pressure then becomes [ ] or [ ] or [ ] Pa (see Appendix 6)

			Air flow, m^3/s		
			Out	In	Remarks
Flow required through open doorway to give protection. See Appendix 6					
At above pressures leaks through closed doors are:	Pa	ΔP			
Total					

Q_1 ($\sum_{IN} - \sum_{OUT}$) [ ] (+ve inwards)

Next, open door to lower pressure area.

Room pressure then becomes [ ] or [ ] or [ ] Pa

			Out	In	Remarks
Flow required through open doorway to give protection					
At above pressures leaks through closed doors are:	Pa	ΔP			
Total					

Q_2 ($\sum_{OUT} - \sum_{IN}$) (+ve outwards)

Flow through transfer device (TD1) to protect door 1 = $Q1$ [ ] at resultant ΔP .....

Flow through transfer device (TD2) to protect door 2 = $Q2$ [ ] at resultant ΔP .....

Designer ..... Date .....

Air movement control **Peripheral room ..... type bay (semi-open)**	**Worksheet WS2e** **Reference:** **Nominal pressure:** **Pa**

Note: If the room is of the open bay type (ie opening is larger than normal single doorway), the room should be considered part of the main room. No air movement control considerations need then be made, and this sheet can be discarded. Supply and/or extract flow will be based on air distribution considerations.

Consider permanent opening

			Air flow, m^3/s		
			Out	In	Remarks
Flow required through opening to give protection					
Leaks through closed doors to:	Pa	ΔP			
Total					

E_{AMC} [ ] or flow outward through transfer device ($\sum_{IN} - \sum_{OUT}$) [ ]

Transfer S_{AMC} or E_{AMC} to WS1

Transfer device – transfer grille [ ]

– pressure stabiliser [ ]

Size select transfer device for flow rate [ ] @ ΔP [ ]

Note: A door from the bay is considered with the peripheral room to which it leads or, if it leads to the corridor, it is considered with the main room

Designer ..... Date .....

Air movement control **Operating room**	**Worksheet WS3** **Reference:** **Nominal pressure:** **Pa**

Note: To avoid considering each door open in turn, the "key door" concept is introduced. This is the door which requires the greatest mechanical flow when open. See paragraph A8.33

Select "key door" (see above).

Consider this door open – room pressure now becomes ____ Pa (see Appendix 6)

See Appendix 7 for room pressures

			Air flow, m^3/s		
			Out	In	Remarks
Flow required through doorway to give protection					
Air flow "out" or "in" via doors, transfer devices etc	Pa	ΔP			
Mechanical extract					
Total					

S_{AMC} ($\sum_{OUT} - \sum_{IN}$) ____ transfer S_{AMC} to WS1

Consider all doors closed.

Return S_F from WS1 ____ Room pressure now ____ Pa (nominal)

Air flow "out" or "in" via door leakage, transfer devices etc	Pa	ΔP	Out	In	Remarks
Mechanical extract and supply					
Total					

Flow ($\sum_{IN} - \sum_{OUT}$) through transfer device ____ @ ΔP ____ to .....

For final selection of transfer device see paragraphs A8.50–A8.54

Designer ..... Date .....

Air movement control **Corridor**			**Worksheet WS4** **Reference:** **Nominal pressure:** **Pa**		
Consider all doors closed					
			Air flow, m^3/s		
			Out	In	Remarks
Flow required through doorway to give protection					
Leaks through closed doors, transfer devices, permanent openings etc	Pa	ΔP			
Total flow inwards (S_1)					
Add mechanical input (S_2) if necessary to increase S_1 to give 7 AC/hr					
Total flow outwards and inwards					
$S_{AMC} = (\sum_{OUT} - \sum_{IN} + S_2)$ ☐ Transfer to WS5					
or $E_{AMC} = (\sum_{IN} - \sum_{OUT} + S_2)$ ☐ Transfer to WS5					

Note: this sheet to be used for each individual operating theatre suite (or pair of suites if they share a preparation room)

Designer ..... Date .....

Air movement control	**Worksheet WS5** **Reference:**	
Summary of air supply and extract for an operating suite		
Air flow to corridor	All doors closed	Anaesthetic (key door open)
	m^3/s	m^3/s
From preparation		
From operating theatre		
From scrub		
From anaesthetic		
Total (a)		
Air flow to corridor From utility		
From other source		
Total (b)		
Other room supplies ..... Total (c)		
Total air supply (a) + (b) + (c)		
Consider corridor ventilation (see Appendix 3) and calculate air volume required, based on 7 AC/hr (see Note 1)		
		m^3/s
Air flow required to ventilate corridor		
Air flow required to ventilate service corridor (see Note 2)		
If the air flow from the operating suite (a) and (b) is greater than the calculated required volume, no further supply air is necessary		
		m^3/s
Additional air to ventilate corridor		
Additional air to ventilate service corridor (see Note 2)		
Air extract The size of the extract plant should be of the order of 10% below the supply to assist in maintaining the department under positive pressure relative to the outside departments		
		m^3/s
Extract plant = Supply less leakage		
Less 10% of supply		
Total extract (see Note 3)		

Notes: 1. In the case of a multi-theatre operating department, the air balance for the corridor should be considered as a separate exercise, taking into account the final dispersal of excess air.
2. Omit these if only one corridor in operating suite.
3. The extract volume includes 0.24 m^3/s from the anaesthetic room for a balanced condition

Designer ..... Date .....

Room temperature – summer	**Worksheet WS6a** **Reference:**

Find summer supply temperature $T_{ss} = 20 - 0.828H(O/R)$ ____

$Q(O/R)$ ____

$= T_{ss}$ ____ °C

Note: the temperature of a space may be calculated from

$$T = \frac{t_1Q_1 + t_2Q_2 + \ldots\ldots\ldots + t_nQ_n + (0.828H)}{Q_1 + Q_2 + \ldots Q_n}$$

Where t_1 is temperature of source 1 (°C)
Q_1 is flow from source 1 when all doors are closed (m^3/s)
H is heat gain in space (kW)

Room	Heat gain kWh	Supply		Flows inwards										Temperature °C T
		Q	T_{ss}	From		From		From		From		From		
				Q	t	Q	t	Q	t	Q	t	Q	t	

Check doors to sterile areas

Door between	Calculated room ΔT (°C)	Maximum ΔT permitted	Remarks

Designer ..... Date .....

Room temperature – winter	**Worksheet WS6b** **Reference:**

Find winter supply temperature $T_{sw} = 20 - 0.828H(O/R)$ ____

$Q(O/R)$ ____

$= T_{sw}$ ____ °C

Note: the temperature of a space may be calculated from

$$T = \frac{t_1Q_1 + t_2Q_2 + \ldots\ldots\ldots + t_nQ_n + (0.828H)}{Q_1 + Q_2 + \ldots Q_n}$$

Where t_1 is temperature of source 1 (°C)
Q_1 is flow from source 1 when all doors are closed (m^3/s)
H is heat gain in space (kW)

Room	Heat gain kWh	Supply		Flows inwards										Temperature °C T
		Q	T_{sw}	From		From		From		From		From		
				Q	t	Q	t	Q	t	Q	t	Q	t	

Check doors to sterile areas

Door between	Calculated room ΔT (°C)	Maximum ΔT permitted	Remarks

Designer ..... Date .....

Transfer grilles, pressure relief dampers and pressure stabilisers	**Worksheet WS7** **Reference:**

Transfer grilles – see paragraphs A8.34–A8.38

No	Location	Pressure difference Pa	Flow rate m^3/s	Free area m^2	Model	Resultant Δp Pa	Remarks

Pressure relief dampers – see paragraph A8.39

No	Location	Pressure difference Pa	Flow rate m^3/s	Free area m^2	Pressure setting Pa	Remarks

Pressure stabilisers – see paragraphs A8.40–A8.43

Note: where a stabiliser is acting both as series room door protection and operating pressure control, "pressure difference" and "flow rate" are from WS2d; "pressure setting" is from WS3

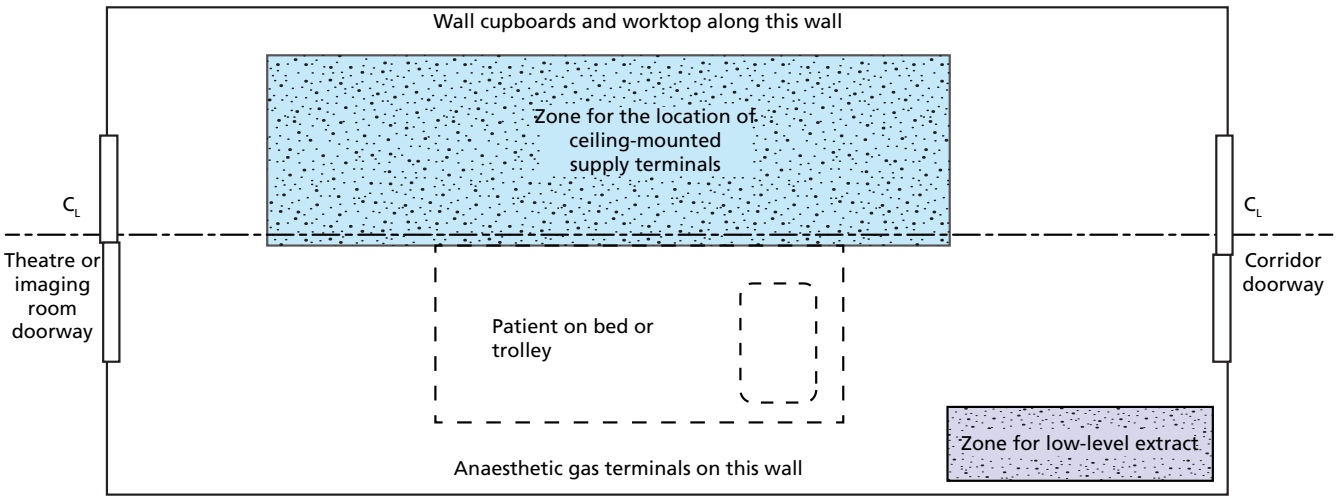
No	Location	Pressure difference Pa	Flow rate m^3/s	Free area m^2	Pressure setting Pa	Remarks

Designer ..... Date .....

Appendix 9: Design of air-movement control scheme for anaesthetic room

General

Figure A8 Schematic of suitable supply and extract terminal zones



The above shows the typical zones for the positioning of ceiling-mounted supply and low-level extracts in an anaesthetic room. The objective is to comply with the COSHH Regulations and HTM 03-01 Part A by providing a clean airflow path for staff working in anaesthetic rooms and so reduce their risk of casual exposure to waste/leaking anaesthetic agents.

Note:
1. Supply terminals should not be positioned above wall-mounted cupboards as this will prevent their output being measured directly with a balometer. It will also negatively impact on the air distribution within the room.

2. See photographs below for details of the recommended low-level extract installation.

3. Low-level extracts should have a spring-clip-retained pull-off grille face for ease of cleaning.

Low-level extract installation

Traditional installation (not recommended)

- Low-level extract easily obstructed by equipment
- Extra corners to clean around

Recommended installation

- Low-level extract cut back at 80° and stops short of the floor.
- No added detail to floor covering or coving.
- No additional corners to clean around.
- Not easily obstructed by equipment.
- Pull-off grille face for ease of cleaning.
- Grille still accessible for airflow measurement.

The photograph is for illustrative purposes only and shows a cutback of approximately 65°. This was found to make airflow measurement quite difficult, hence the change to an 80° cutback so that measurement can be easily taken with a balometer.

Operating theatre to anaesthetic room air-transfer device

The air-transfer device between an operating theatre and anaesthetic room may be either by a transfer grille or pressure stabiliser. The choice will be determined by the volume of air to be transferred. Paragraphs A8.51 and A8.52 in Appendix 8 give details.

Appendix 10: Example cause-and-effect check-sheets

Example cause-and-effect check-sheet for general theatre or imaging suite

Site			Date		
Area served			System ID		
	Test	AHU Checks	Y/N	TCP Indication	Y/N
1	AHU Off	Supply and extract dampers closed		Red	
2	Switch AHU "On"	Supply damper open Extract damper open		Red	
		Supply fan start and run Extract fan start and run		Red	
		Prove airflow		Green	
3	Switch AHU to "Set Back"	Supply fan slows Extract fan slows		Red	
4	Switch AHU to Operational speed	Supply fan speeds up Extract fan speeds up		Green	
5	End of day 10 minute warning that system will switch to "Set Back" *(Not all TCPs have this facility)*			Yellow display information box	
	Do nothing	System goes to "Set back"		Red	
	Reset to full speed			Green	
6	End of day 10 minute warning that system will switch to "Set Back" *(Not all TCPs have this facility)*			Yellow display information box	
	Press "Continue"	System stays at full speed for 1 hour		Green	
7	Supply fan fail	System shuts down		Red	
	Reset system to normal			Green	
8	Extract fan fails	Warning on TCP and BMS. AHU locks out if fault not rectified by following day		Yellow display information box	
	Reset system to normal			Green	
9	Theatre/Imaging room temperature to be stable at 20°C at the start of this test.				
	Reduce set point temperature to lowest possible on TCP	Chiller battery valve opens fully Record min temp reached and time taken to stabilise.		Set temp: °C Measured: °C Ind (TCP) °C Time taken mins	
10	Increase set point temperature to highest possible on TCP	Heater battery valve opens fully. Record max temp reached and time taken to stabilise.		Set temp: °C Measured: °C Ind (TCP) °C Time taken mins	
	Reset set point to 20°C			Green	
11	Switch AHU "Off"	Extract fan stops Supply fan stops Extract damper closes Supply damper closes		Red	

Example cause-and-effect check-sheet for ultra-clean theatres

Site		Date	
Area served		System ID	

	Test	AHU/UCV Checks	Y/N	TCP Indication	Y/N
1	AHU Off	Supply and extract dampers closed		Red	
2	Switch AHU "On"	Supply damper open Extract damper open		Red	
		Supply fan start and run Extract fan start and run		Red	
		Prove airflow UCV "Off"		Red	
3	Switch AHU to "Set Back"	Supply fan slows Extract fan slows		Red	
4	Switch AHU to Operational speed	Supply fan speeds up Extract fan speeds up		–	
5	AHU at operational speed	Switch UCV on in "Low speed"		Amber = "Conventional Theatre mode"	
	Press "UCV mode"	UCV goes to "Full speed"		Green "UCV Theatre Mode"	
	Press "Conventional Theatre mode"	UCV goes to "Low speed"		Amber	
6	Switch AHU to "Set Back"	UCV goes to "Low speed" or "Off"		Red	
	Reset system to normal	UCV stays in "Low speed"		Amber	
7	Switch UCV "Off"	UCV fans stop		Red	
	Reset system to normal with UCV at full speed			Green	
8	Fail each UCV quadrant fan in turn and Coanda fans (4 + 2)			Red	
	Reset system to normal with UCV at full speed			Green	
9	Trigger HEPA filter high pressure switch			Green plus Blue light	
10	End of day 10 minute warning that system will switch to "Set Back" or "Off" *(Not all Theatre Control Panels have this facility)*			Yellow display information box	
	Do nothing	AHU & UCV go to "Set back" or "Off"		Red	
	Reset to full speed including UCV			Green	
11	End of day 10 minute warning that system will switch to "Set Back" or "Off" *(Not all Theatre Control Panels have this facility)*			Yellow display information box	
	Press "Continue"	System stays at full speed for 1 hour		Green	
12	Supply fan fails	System shuts down. UCV to "Low speed or Off"		Red	
	Reset system to normal			Green	
13	Extract fan fails	Warning on TCP and BMS.AHU locks out if fault not rectified by following day		Yellow display information box	
	Reset system to normal and UCV to full speed			Green	

Site			Date		
Area served			System ID		
Test	**AHU/UCV Checks**	**Y/N**	**TCP Indication**		**Y/N**
14	Theatre temperature to be stable at 20°C at the start of this test.				
	Reduce set point temperature to lowest possible on TCP	Chiller battery valve opens fully Record min temp reached and time taken to stabilise		Set temp: Measured: Ind (TP) Time taken	°C °C °C mins
15	Increase set point temperature to highest possible on TCP	Heater battery valve opens fully Record max temp reached and time taken to stabilise		Set temp: Measured: Ind (TP) Time taken	°C °C °C mins
	Reset set point to 20°C			Green	
16	Switch AHU "Off"	Extract fan stops Supply fan stops Extract damper closes Supply damper closes UCV drops to "Set back"		Red	
Note any additional tests or checks below					

References

Acts and regulations

Building Regulations 2010. SI 2010 No 2214.
http://www.legislation.gov.uk/uksi/2010/2214/contents/made

Control of Substances Hazardous to Health Regulations 2002. SI 2002 No 2677.
http://www.legislation.gov.uk/uksi/2002/2677/regulation/7/made

Health and Social Care Act 2008 (Regulated Activities) Regulations 2014.
https://www.legislation.gov.uk/ukdsi/2014/9780111117613/contents

Health and Safety at Work etc. Act 1974. HMSO, 1974.
http://www.legislation.gov.uk/ukpga/1974/37/contents

Human Medicines Regulations 2012. SI 2012 No 1916.
http://www.legislation.gov.uk/uksi/2012/1916/contents/made

Medicines Act 1968 c.67.
http://www.legislation.gov.uk/ukpga/1968/67

Workplace (Health, Safety and Welfare) Regulations 1992. SI 1992 No 3004.
http://www.legislation.gov.uk/uksi/1992/3004/contents/made

Building Regulations Approved Documents

Building Regulations 2010: Approved Document F: Ventilation. Ministry of Housing, Communities & Local Government, 2010.
https://www.gov.uk/government/publications/ventilation-approved-document-f

Building Regulations 2010: Approved Document L: Conservation of fuel and power. Ministry of Housing, Communities & Local Government, 2018.
https://www.gov.uk/government/publications/conservation-of-fuel-and-power-approved-document-l

European regulations

Commission Regulation (EU) No 1253/2014 of 7 July 2014 implementing Directive 2009/125/EC of the European Parliament and of the Council with regard to ecodesign requirements for ventilation units.
https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv%3AOJ.L_.2014.337.01.0008.01.ENG

Directive 2009/125/EC of the European Parliament and of the Council of 21 October 2009 establishing a framework for the setting of ecodesign requirements for energy-related products. https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A32009L0125

Regulation (EU) No 517/2014 of the European Parliament and of the Council of 16 April 2014 on Fluorinated Greenhouse Gases and Repealing Regulation (EC) No 842/2006. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32014R0517

British Standards

BS 1710. Specification for identification of pipelines and services. British Standards Institution, 2014.

BS 5925. Code of practice for ventilation principles and designing for natural ventilation. British Standards Institution, 1991.

BS 7671. Requirements for electrical installations. IET Wiring Regulations. British Standards Institution, 2018.

BS EN 1751. Ventilation for buildings. Air terminal devices. Aerodynamic testing of damper and valves. British Standards Institution, 2014.

BS EN 1822-1. High efficiency air filters (EPA, HEPA and ULPA). Classification, performance testing, marking. British Standards Institution, 2019.

BS EN 1886. Ventilation for buildings. Air handling units. Mechanical performance. British Standards Institution, 2007.

BS EN 13030. Ventilation for buildings. Terminals. Performance testing of louvres subjected to simulated rain. British Standards Institution, 2001.

BS EN ISO 14644-1. Cleanrooms and associated controlled environments. Classification of air cleanliness by particle concentration. British Standards Institution, 2015.

BS EN 15780. Ventilation for buildings. Ductwork. Cleanliness of ventilation systems. British Standards Institution, 2011.

BS EN 16798-3. Energy performance of buildings. Ventilation for buildings. For non-residential buildings. Performance requirements for ventilation and room-conditioning systems (Modules M5-1, M5-4). British Standards Institution, 2017.

BS EN ISO 16890-1. Air filters for general ventilation. Part 1: Technical specifications, requirements and classification system based upon particulate matter efficiency (ePM). British Standards Institution, 2016.

Health and Safety Executive guidance

Health and Safety Executive (2008). **HSG258 Controlling airborne contaminants at work: a guide to local exhaust ventilation (LEV).** HSE Books, Sudbury. https://www.hse.gov.uk/pubns/books/hsg258.htm

Health and Safety Executive (2013). **Approved Code of Practice and guidance on regulations. Legionnaires' disease: The control of *legionella* bacteria in water systems (L8).** (4th edition). HSE Books, Sudbury. https://www.hse.gov.uk/pubns/books/l8.htm

Health and Safety Executive (2014). **HSG274 Legionnaires' disease – technical guidance. Part 2: The control of *legionella* bacteria in hot and cold water systems.** HSE Books, Sudbury. https://www.hse.gov.uk/pubns/books/hsg274.htm

Health and Safety Executive (2014). **HSG274 Legionnaires' disease – technical guidance. Part 3: The control of *legionella* bacteria in other risk systems.** HSE Books, Sudbury. http://www.hse.gov.uk/pubns/priced/hsg274part3.pdf

Department of Health (2015). **The Health and Social Care Act 2008 Code of Practice on the prevention and control of infections and related guidance.** https://www.gov.uk/government/publications/the-health-and-social-care-act-2008-code-of-practice-on-the-prevention-and-control-of-infections-and-related-guidance

Health and Safety Executive (2020). **EH40/2005 Workplace exposure limits: containing the list of workplace exposure limits for use with the Control of Substances Hazardous to Health Regulations 2002 (as amended).** HSE Books, Sudbury. https://www.hse.gov.uk/pubns/books/eh40.htm

Health Technical Memoranda

Health Technical Memorandum 02-01. Medical gas pipeline systems. https://www.gov.uk/government/publications/medical-gas-pipeline-systems-part-a-design-installation-validation-and-verification

Health Technical Memorandum 04-01. Safe water in healthcare premises. https://www.gov.uk/government/publications/hot-and-cold-water-supply-storage-and-distribution-systems-for-healthcare-premises

Health Technical Memorandum 05-01. Managing healthcare fire safety. https://www.gov.uk/government/publications/managing-healthcare-fire-safety

Health Technical Memorandum 05-02. Fire safety in the design of healthcare premises. https://www.gov.uk/government/publications/guidance-in-support-of-functional-provisions-for-healthcare-premises

Health Technical Memorandum 05-03. Fire safety measures for health sector buildings https://www.gov.uk/government/publications/suite-of-guidance-on-fire-safety-throughout-healthcare-premises-parts-a-to-m

Health Technical Memorandum 06-01. Decontamination of flexible endoscopes. https://www.gov.uk/government/publications/management-and-decontamination-of-flexible-endoscopes

Health Technical Memorandum 08-01. Acoustics. https://www.gov.uk/government/publications/guidance-on-acoustic-requirements-in-the-design-of-healthcare-facilities

Health Building Notes

Health Building Note 00-10 Part D – Windows. https://www.gov.uk/government/publications/guidance-on-flooring-walls-and-ceilings-and-sanitary-assemblies-in-healthcare-facilities

Health Building Note 04-01. Adult in-patient facilities. https://www.gov.uk/government/publications/adult-in-patient-facilities

Health Building Note 04-01. Supplement 1 – Isolation facilities for infectious patients in acute settings. https://www.gov.uk/government/publications/adult-in-patient-facilities

Health Building Note 04-02. Critical care units. https://www.gov.uk/government/publications/guidance-for-the-planning-and-design-of-critical-care-units

Health Building Note 10-01. Facilities for surgery (forthcoming).

Health Building Note 26. Facilities for surgical procedures. https://www.gov.uk/government/publications/facilities-guidance-for-surgical-procedures-in-acute-general-hospitals

Health Building Note 26 – 'Facilities for surgical procedures' (2004) and Health Building Note 10-02 'Facilities for day surgery units' (2007) are currently under revision and will become Health Building Note 10-01 once updated.

Other publications

Advisory Committee on Dangerous Pathogens (2001). **The management, design and operation of microbiological containment laboratories.** https://www.hse.gov.uk/biosafety/management-containment-labs.pdf

Advisory Committee on Dangerous Pathogens (2005). Biological agents: managing the risks in laboratories and healthcare premises. https://www.gla.ac.uk/media/Media_196331_smxx.pdf

Advisory Committee on Dangerous Pathogens (2009). Biological agents: the principles, design and operation of Containment Level 4 facilities. https://www.hse.gov.uk/pubns/web09.pdf

BESA (2013). **DW 143: Guide to good practice: ductwork air leakage testing.** B&ES Publications, Penrith.

BESA (2016). **DW 144: Specification for sheet metal ductwork.** B&ES Publications, Penrith.

BESA (2020). **DW 145: Guide to good practice for the installation of fire and smoke dampers.** B&ES Publications, Penrith.

BESA (2020). **DW 172: Specification for kitchen ventilation systems.** B&ES Publications, Penrith.

BESA (2019). **TR/19: Guide to good practice – internal cleanliness of ventilation systems.** B&ES Publications, Penrith.

BSRIA (2015). **BG 49: Commissioning air systems.** BSRIA, Bracknell.

BSRIA (2018). **BTS 3: Air permeability testing of isolation facilities.** BSRIA, Bracknell. https://www.bsria.com/uk/product/BA8E4D/air_permeability_testing_of_isolation_facilities_bts_32018_a15d25e1/

BSRIA (2018). **Soft landings.** https://www.bsria.com/uk/consultancy/project-improvement/soft-landings/guides/

CIBSE (2005). **AM10: Natural ventilation in non-domestic buildings.** CIBSE, London.

CIBSE (2000). **AM13 Mixed mode ventilation systems.** CIBSE, London.

CIBSE (2006). **CCA Commissioning Code A: Air distribution systems.** CIBSE, London.

CIBSE (2003). **CCM Commissioning Code M: Commissioning management.** CIBSE, London.

CIBSE (2002). **CCR Commissioning Code R: Refrigerating systems.** CIBSE, London.

CIBSE (2010). **CCW Commissioning Code W: Water distribution systems.** CIBSE, London.

CIBSE (2015). **Guide A: Environmental design.** CIBSE, London.

CIBSE (2016). **Guide B2: Ventilation and ductwork.** CIBSE, London.

CIBSE (2014). **TM49: Design summer years for London.** CIBSE, London.

CIBSE (2013). **TM52: The limits of thermal comfort: avoiding overheating in European buildings.** CIBSE, London.

European Commission (2011). **EudraLex. Volume 4: Good manufacturing practice (GMP) guidelines.** (Partly revised in 2017.) https://ec.europa.eu/health/documents/eudralex/vol-4_en

Humphreys, H., Coia, J.E., Stacey, A., Thomas, M., Belli, A.M., Hoffman, P., ... and Mackintosh, C.A. (2012). 'Guidelines on the facilities required for minor surgical procedures and minimal access interventions'. Journal of Hospital Infection, Vol. 80 No. 2, pp. 103–109. http://www.aspc-uk.net/wp-content/uploads/2014/03/Facilities-for-minor-surgery.pdf

Lidwell, O.M., ed. (1972). **Ventilation in operation suites. Report of a Joint DHSS/MRC Working Party.** Department of Health and Social Security. HMSO, London.

Lidwell, O.M., Lowbury, E.J., Whyte, W., Blowers, R., Stanley, S.J. and Lowe, D. (1982). 'Effect of ultraclean air in operating rooms on deep sepsis in the joint after total hip or knee replacement: a randomised study'. *British Medical Journal (Clinical Research Ed.)*, Vol. 285 No. 6334, pp. 10–14.

Medical Research Council (2014). **Standards for containment level 3 facilities.** https://mrc.ukri.org/documents/pdf/ssr/standards-for-containment-level-3-facilities/

National Institute for Health and Care Excellence (2020). **NICE guideline [NG149]. Indoor air quality at home.** https://www.nice.org.uk/guidance/ng149

Royal College of Paediatrics and Child Health (2020). **The inside story: health effects of indoor air quality on children and young people.** https://www.rcpch.ac.uk/resources/inside-story-health-effects-indoor-air-quality-children-young-people

Specialised Ventilation for Healthcare Society (2017). **SVHSoc.01 – Operating theatres: energy control strategies and the surgeon's panel.** https://svhsoc.com/wp-content/uploads/2019/03/operating-theatre-surgeons-panel-and-control-strategies-1.pdf

Specialised Ventilation for Healthcare Society (2018). **SVHSoc.02 – Change in air filter test and classification standards.** https://svhsoc.com/wp-content/uploads/2019/03/change-in-air-filter-classification-1.pdf

Other guidance

For guidance from the World Health Organization on indoor air quality, visit WHO's website at https://www.who.int/airpollution/guidelines/en/#:~:text=The%20guidelines%20aim%20to%20eliminate,basis%20for%20legally%20enforceable%20standards.

Note:

In all cases the most recent version of any Legislation, Regulation, Standard or Guidance document should be consulted.

Abbreviations used in this document

ac/h	Air changes per hour
ACDP*	Advisory Committee on Dangerous Pathogens*
ACOP	Approved Code of Practice
AE(V)	Authorising Engineer (ventilation)
AGP	Aerosol-generating procedure
AHU	Air handling unit
AP(V)	Authorised Person (ventilation)
BESA	Building Engineering Services Association
BIM	Building Information Model
BMS	Building Management System
BEMS	Building Energy Management System
BS EN	British Standard European Number
BSRIA	Building Services Research and Information Association
CCA	Critical care area (Level 2 & 3 care)
cfu	Colony forming unit
CIBSE	Chartered Institution of Building Services Engineers
COSHH	Control of Substances Hazardous To Health
CP(V)	Competent Person (ventilation)
CT	Computed tomography (imaging)
DIPC	Director of Infection Prevention and Control
DOP	Dispersed oil particles
DX	Direct expansion (refrigeration cycle)
EC	Electronicaly commutated (fan)
EPA	Efficiency particulate air filter (E10 to E12)
ErP	Energy related products
EU GGMP	European Guide to Good Manufacturing Process (pharmacy)
GRP	Glass reinforced polymer
HBN	Health Building Note
HEPA	High efficiency particulate air filter (H13 to H14)
HIS	Healthcare Infection Society
HTM	Health Technical Memoranda
IAP	Inspection, assembly and packing (room)
ISO	International Standards Organisation
Level 0 care	Patients whose needs can be met through normal ward care in an acute hospital
Level 1 care	Patients at risk of their condition deteriorating, or recently relocated from higher levels of care, whose needs can be met through normal ward care with additional advice and support from the critical care team.
Level 2 care	Patients requiring more detailed observation or intervention, including support for a single failing organ system or post-operative care and those 'stepping down' from higher levels of care.
Level 3 care	Patients requiring advanced respiratory support alone or monitoring and support for two or more organ systems. This level includes all complex patients requiring support for multi-organ failure.
LEV	Local exhaust ventilation
LSAPC	Light scattering airborne particle counter

MDR-TB	Multi-drug-resistant tuberculosis
MRI	Magnetic resonance imaging
NICU	Neonate intensive care unit
PFI	Private Finance Initiative
PPVL	Positive pressure ventilated lobby (isolation room)
PVC	Polyvinyl chloride
RH	Relative humidity
SCBU	Special care baby unit
SPATA	The Swimming Pool and Allied Trades Association
SVHSoc	Specialised Ventilation for Healthcare Society
TB	Tuberculosis
TCP	Theatre control panel
UCV	Ultra clean ventilation
ULPA	Ultra low particulate air filter (U15 to U17)
UV	Ultraviolet
VAV	Variable air volume
VCD	Volume control damper
VSG	Ventilation Safety Group
WEL	Workplace exposure limit

Symbols used	
°C(db)	Degrees centigrade (Dry bulb) temperature
K	Kelvin (temperature difference)
% RH	Percentage relative humidity
L/s	Litres per second
µm	Micrometres, microns
ePM1, 2.5, 10	Particle size in micrometres
≥	Equal to or greater than

* ACDP Containment levels

Category 1 biohazard: a biological agent unlikely to cause human disease

Category 2 biohazard: a biological agent that can cause human disease and may be a hazard to employees; it is unlikely to spread to the community and there is usually effective prophylaxis or effective treatment available.

Category 3 biohazard: a biological agent that can cause severe human disease and presents a serious hazard to employees; it may present a risk of spread to the community, but there is usually effective treatment or prophylaxis available.

Category 4 biohazard: a biological agent that causes severe human disease and is a serious hazard to employees; it is likely to spread to the community and there is usually no effective prophylaxis or treatment available.

NHS England and NHS Improvement
Skipton House
80 London Road
London
SE1 6LH

This publication can be made available in a number of other formats on request.

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Tuberculosis

Clinical diagnosis and management of tuberculosis, and measures for its prevention and control

This is the full version of NICE clinical guideline 117. It contains details of the methods and evidence used to develop the guideline. It updates and replaces the full version of 'Tuberculosis: clinical diagnosis and management of tuberculosis, and measures for its prevention and control' that was developed by the National Collaborating Centre for Chronic Conditions and published by the Royal College of Physicians in March 2006. The updated recommendations have been developed by the Centre for Clinical Practice at NICE following the NICE short clinical guideline process.

NICE clinical guideline 117

Developed by the National Collaborating Centre for Chronic Conditions and the Centre for Clinical Practice at NICE

This guidance updates and replaces 'Tuberculosis: clinical diagnosis and management of tuberculosis, and measures for its prevention and control' (developed by the National Collaborating Centre for Chronic Conditions [now the National Clinical Guideline Centre] and published by the Royal College of Physicians in March 2006).

New recommendations on the use of interferon-gamma tests for the diagnosis of latent tuberculosis have been added. Updated recommendations have been developed by the Centre for Clinical Practice at NICE.

A grey bar in the righthand margin indicates text from the 2006 guideline and text that was added or updated in 2011.

- **2006** indicates that the evidence has not been updated and reviewed since the original guideline.
- **2006, amended 2011** indicates that the evidence has not been updated and reviewed since 2006 but a small amendment has been made to the recommendation.
- **new 2011** indicates that the evidence has been reviewed and the recommendation has been updated or added.

Royal College of Physicians

11 St Andrews Place
London NW1 4LE

www.rcplondon.ac.uk

Registered charity No 210508

National Institute for Health and Clinical Excellence

MidCity Place
71 High Holborn
London WC1V 6NA

www.nice.org.uk

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Contents

2006, amended 2011

Background

New 2011

In 2006 the National Collaborating Centre for Chronic Conditions published guidance on the clinical diagnosis and management of tuberculosis (TB), and measures for its prevention and control. In this guidance the section on the diagnosis of latent TB has been updated by the Short Clinical Guidelines team within NICE. Grey bars in the right hand margin indicate whether the section has been updated (2011) or is from the original guideline (2006).

Preface - 2006

2006

Tuberculosis, or TB, is one of man's oldest foes and for centuries among the most feared. One of the triumphs of modern medicine has been the development of vaccination and medication capable of combating this ancient disease, and it now rarely troubles the thoughts of those born into modern Western society. Yet TB remains capable of exciting occasional major concern, for example when reports of local outbreaks emerge, and this continuing wariness is appropriate. Although TB notifications fell steadily for most of the twentieth century, this fall was not maintained in the last decade. Some racial groups have much higher TB incidence than others and, irrespective of ethnicity, the disease is more common in those in deprived social circumstances. Moreover, there are huge reservoirs of TB elsewhere in the world, with the additional spectre of growing pockets of infection resistant to available treatment. For all these reasons it is still necessary to focus attention on the optimum management of TB, and that is the purpose of this guideline.

The guideline has been commissioned by NICE as a successor to the British Thoracic Society's TB guidelines, which have been used with great benefit for many years as the principal source of advice on TB management in the UK. The scope of the guideline is unusually wide, and we were obliged to divide the work between two separate guideline development groups, one covering diagnosis and management, the other prevention and control. Both groups used what has become our standard methodology, first identifying the key aspects of the disease and then searching out and appraising the best

relevant evidence. In some areas, particularly those around prevention and control, it has been unusually difficult to find strong evidence. In all cases the guideline groups have attempted to produce practical recommendations, however much or little evidence they had to work on. In addition, great efforts were made to link the advice contained in the guideline to that available from other sources, in particular advice from the Joint Committee on Vaccination and Immunisation.

Although TB will not affect the majority of the UK population, some of the recommendations in the guideline will do so. For years, all secondary school children have been given Bacille Calmette-Guèrin (BCG) vaccination through the schools programme. The current epidemiology of TB in the UK suggests that this is inappropriate and that vaccination efforts should be targeted towards those most at risk, with a change in emphasis towards offering BCG to neonates. This will bring challenges for implementation, and this is not the only recommendation in the guideline which will do so. Directly observed therapy is not necessary as a routine, but is appropriate in those unlikely to adhere to the required treatment regime. This will necessitate careful risk assessment. The guideline also recommends that all people with TB should have a key worker to help educate and promote treatment adherence. These measures are important to the individuals with TB and to the wider community since effective management of patients and contacts is critical to avoiding the development and spread of drug-resistant TB.

The two guideline development groups have each had to meet their own challenges in the development of this document. Their sincere desire to get the best for patients with TB has been evident to those of us involved in the administration of the project, and we are grateful to them for this commitment as well as their expertise. Particular thanks are due to the clinical advisor, Peter Ormerod, who sat on both groups. I believe their efforts have resulted in a comprehensive and authoritative guideline, which should serve the NHS well in the short and medium term and provide a firm basis for future development and improvement in TB management.

Dr Bernard Higgins MD FRCP

2006

Preface – 2011

The 2006 guideline was reviewed for update in 2009, leading to a partial update that resulted in new recommendations for the diagnosis of latent TB (chapter 5).

In 2006 there was a lack of evidence available on the diagnostic utility of interferon-gamma tests (IGTs) and it was noted that there would need to be a partial update of the guideline to make recommendations on the use of IGTs for diagnosis of latent TB once additional evidence came available. The perception in 2006 was that this additional scientific evidence would have emerged by the time the guideline was due for review. There was also a concern that practice would have moved on and was then not in line with the recommended strategies. NICE concluded that because IGT is now commonly used the guideline should be updated but be only in the section(s) relevant to the use of IGT in the diagnosis of latent TB. Therefore, in October 2009 the Department of Health formally asked NICE to produce a short clinical guideline on interferon-gamma immunological testing for diagnosing latent TB (partial review of CG33).

1 Introduction

1.1 Background information

This guideline deals with activities undertaken by professionals in the NHS with the aims of diagnosing primary cases of tuberculosis (TB), identifying secondary cases, treating active disease, controlling latent infection and preventing further transmission. At a population level, the combined result of these activities should be to curb and then reverse the increase in TB seen in England and Wales in recent years. TB is a disease of poverty, and specific groups of the population are at heightened risk. To address this, the guideline provides recommendations, wherever there is evidence to support it, on ways

of organising services efficiently to provide the best possible care. Almost all cases of TB are preventable, and almost all people with TB can be cured.

What causes TB?

TB is caused by a bacterium called *Mycobacterium tuberculosis* (‘*M. tuberculosis*’ or ‘*M.Tb*’). It is spread by one person inhaling the bacterium in droplets coughed or sneezed out by someone with infectious tuberculosis. Not all forms of tuberculosis are infectious. Those with TB in organs other than the lungs are rarely infectious to others, and nor are people with just latent tuberculosis (see below). Some people with respiratory tuberculosis are infectious, particularly those with bacteria which can be seen on simple microscope examination of the sputum, who are termed ‘smear positive’. The risk of becoming infected depends principally on how long and how intense the exposure to the bacterium is. The risk is greatest in those with prolonged, close household exposure to a person with infectious TB.

What happens after infection?

Once inhaled the bacteria reach the lung and grow slowly over several weeks. The body’s immune system is stimulated, which can be shown by a Mantoux test[1], a common diagnostic technique. In over 80% of people the immune system kills the bacteria and they are removed from the body. In a small number of cases a defensive barrier is built round the infection but the TB bacteria are not killed and lie dormant. This is called latent tuberculosis; the person is not ill and is not infectious. Sometimes at the time of the initial infection, bacteria get into the blood stream and can be carried to other parts of the body, such as bones, lymph glands or the brain, before the defensive barrier is built. One third of the world’s population, two billion people, have latent tuberculosis.

If the immune system fails to build the defensive barrier, or the barrier fails later, latent tuberculosis can spread within the lung (pulmonary tuberculosis) or into the lymph glands within the chest (intrathoracic respiratory tuberculosis) or develop in the other part(s) of the body it has spread to

2006

[1] Tuberculin skin test (TST) has been replaced with Mantoux test, throughout the document

(extrapulmonary tuberculosis). Only some of those with latent tuberculosis will develop symptoms ('active tuberculosis'). About half the cases of active tuberculosis develop within a few years of the original infection, particularly in children and young adults. The other half of active TB cases arise from reactivation of the latent infection many years later.

Who catches TB?

Anyone can catch TB but those at particular risk are those who have been exposed to TB bacteria, and those who are less able to fight latent infection. They include:

- close contacts of infectious cases
- those who have lived in, travel to or receive visitors from places where TB is still very common
- those who live in ethnic minority communities originating from places where TB is very common
- those with immune systems weakened by HIV infection or other medical problems
- the very young and the elderly, as their immune systems are less robust
- those with chronic poor health and nutrition because of lifestyle problems such as homelessness, drug abuse or alcoholism
- those living in poor or crowded housing conditions, including those living in hostels.

What are the symptoms of TB?

Because TB can affect many sites in the body, there can be a wide range of symptoms, some of which are not specific and may delay diagnosis.

Typical symptoms of pulmonary TB include chronic cough, weight loss, intermittent fever, night sweats and coughing blood. TB in parts other than the lungs has symptoms which depend on the site, and may be accompanied by intermittent fever or weight loss. TB is a possible diagnosis to be considered in anyone with intermittent fever, weight loss and other unexplained symptoms. Latent tuberculosis without disease, however, has no symptoms.

How is TB diagnosed?

TB is diagnosed in a number of ways. Tissue samples from biopsies may show changes which suggest TB, as do certain X-ray changes, particularly on chest X-rays. Definite diagnosis is achieved by culturing the TB bacterium from sputum or other samples. This not only confirms the diagnosis, but also shows which of the TB drugs the bacterium is sensitive to. Mantoux test and IGTs can show if someone has been exposed to TB and may have latent infection. Skin tests use a tiny dose of TB protein injected under the skin. In people who have been exposed to TB this gives a positive reaction, which is seen as a raised, red area. IGTs involve taking a blood sample, which is processed at a laboratory.

How is TB treated?

TB is completely curable if the correct drugs are taken for the correct length of time. Before drug treatment for TB nearly half of all persons with active tuberculosis died from it. Several antibiotics need to be taken over a number of months to prevent resistance developing to the TB drugs. The great majority of TB bacteria are sensitive to the antibiotics used (rifampicin, isoniazid, pyrazinamide and ethambutol). A minority of cases, 6–8% in England and Wales, are resistant to one of the antibiotics. Isoniazid and rifampicin are ineffective in 1% of cases. These cases are said to be of multi-drug resistant TB (MDR TB), which is harder to treat (see Appendix G for details of TB epidemiology).

TB bacteria grow very slowly and divide only occasionally when the antibiotics start to kill them, so treatment usually has to be continued for six months to ensure all active and dormant bacteria are killed and the person with TB is cured. People with respiratory TB are usually not infectious after two weeks of treatment. Drug-resistant forms of the bacteria require treatment for longer than six months. MDR TB is particularly serious, requiring prolonged (up to 24 months) treatment, with the infectious period lasting much longer.

In latent tuberculosis there are many thousand times fewer TB bacteria than in active tuberculosis. Treatment with a single drug for six months, or two

drugs for a shorter time, is sufficient to kill the dormant bacteria, preventing the person developing active tuberculosis later in their life.

Following TB treatment, the disease can return (relapse) in a small number of people, because not all bacteria have been killed. This is obviously much more likely if the course of treatment has been interrupted, not completed or otherwise not followed. However, it is also possible to catch TB a second time, unlike some other infectious diseases.

1.2 Epidemiology of TB in England and Wales

Detailed information on the epidemiology of tuberculosis is provided in Appendix G. Up-to-date epidemiological information, including reports of notifications and enhanced surveillance, is available from the Health Protection Agency (www.hpa.org.uk).

Historical trends

The TB notification system, implemented in 1913, showed that recorded TB rates peaked in England and Wales in the early part of the twentieth century, when 300 new cases per 100,000 people were reported every year. Since then, until the mid 1980s at least, the incidence of tuberculosis has been falling: in 1987 there were only 10 new cases per 100,000 people.

Geographical variations in incidence

There are marked differences in the incidence of tuberculosis in different parts of England and Wales, with most new cases occurring in cities. For example, there were 38 new cases per year per 100,000 population in London in 2001, as compared to less than five in the south west of England. There are also substantial variations in incidence of TB within cities, with as much as a thirtyfold difference between different London boroughs.

Variations in incidence by ethnicity and place of birth

Risk of TB is significantly higher in people from minority ethnic groups, as is evident in Table 1.

Table 1: Tuberculosis rates by ethnicity in England and Wales, 2001

Ethnicity	TB cases per 100,000 population
Black African	211
Pakistani	145
Indian	104
White	4

2006

People born abroad were fifteen times more likely to contract tuberculosis as people born in England and Wales. The majority of cases in people born abroad occur after they have lived in the UK for several years.

2 Methodology - 2006

2.1 Aim

With this document the National Collaborating Centre for Chronic Conditions (NCC-CC) has aimed to provide a user-friendly, clinical, evidence-based guideline for the NHS in England and Wales that:

- offers best practice advice for TB
- is based on best published evidence and expert consensus
- takes into account patient choice and informed decision-making
- defines the major components of the care provision for tuberculosis such as the diagnosis and management of both latent and active TB, and measures for its prevention and control
- indicates areas suitable for clinical audit
- details areas of uncertainty or controversy requiring further research
- provides a choice of guideline versions for differing audiences (full version, short version, quick reference guide and public version) in electronic or printed format.

In contrast to most clinical guidelines commissioned by NICE, the prevention and control sections of this guideline include recommendations on service organisation where good quality evidence exists to support them.

2.2 Scope

The guideline was developed in accordance with a specified scope, which detailed the remit of the guideline originating from the Department of Health (DH) and specified those aspects of TB to be included and excluded.

Before development of the guideline began, the scope was subjected to stakeholder consultation in accordance with processes established by NICE.{1}(National Institute for Health and Clinical Excellence 2005) The scope is given in Appendix E.

2.3 Audience

The guideline is intended for use with the following people or organisations:

- all healthcare professionals
- people with, or at risk from, tuberculosis, and their carers
- patient support groups
- commissioning organisations
- service providers.

Involvement of people with TB

The NCC-CC was keen to ensure the views and preferences of people with TB and their carers informed all stages of the guideline. This was achieved by:

- consulting the Patient Information Unit (PIU) housed within NICE during the pre-development (scoping) and final validation stages of the guideline
- having two former TB patients and two user organisation representatives on the Guideline Development Group (GDG).

The patient and carer representatives were present at every meeting of the GDG. They were therefore involved at all stages of the guideline development process and were able to consult with their wider constituencies.

2.4 Guideline limitations

These include:

- the diagnosis and treatment chapters of this guideline (5–10), except rapid diagnostic techniques (5.3 and 5.4), do not cover issues of service delivery, organisation or provision (as this was not specified in the remit from the DH)
- NICE is primarily concerned with health services and so recommendations are not provided for Social Services and the voluntary

sector. However, the guideline may address important issues in how NHS clinicians interface with these other sectors

- generally the guideline does not cover rare, complex, complicated or unusual conditions.

2.5 Other work relevant to the guideline

Readers of this guideline should also be aware of the following publications:

- *Stopping tuberculosis in England and Wales*, the Chief Medical Officer's TB Action Plan{2}
- *Immunisation against infectious disease* (the 'Green Book'){3}
- *The clinical and cost-effectiveness of diagnostic tests for the detection of mycobacterial infection*, a health technology appraisal due for publication mid 2006 (see www.ncchta.org).

The National Knowledge Service is a relatively new national NHS body which is investigating ways of making patient and public information available to patients and the NHS, amongst other functions. One of the initial pilot projects is in tuberculosis, and is linked to this guideline. See www.hpa.org.uk/tbknowledge for more detail.

The Secretary of State for Health is advised on broader national policy on vaccination by the DH's Joint Committee on Vaccination and Immunisation (JCVI) (http://www.dh.gov.uk/ab/jcvi/index.htm).

Information on TB epidemiology in the UK and abroad, as well as some background information for patients and the public, is available through the Health Protection Agency's website at www.hpa.org.uk. This is referred to at relevant points in this guideline.

2.5.1 Related NICE guidance

Published

- Medicines adherence NICE clinical guideline 76 (2009). Available from www.nice.org.uk/guidance/cg76

2006

Under development

NICE is developing the following guidance (details available from www.nice.org.uk):

- Tuberculosis: hard-to-reach groups. NICE public health guidance. Publication expected March 2012.

2.6 Background

The development of this evidence-based clinical guideline draws upon the methods described by the NICE Guideline Development Methods manual{1} (www.nice.org.uk/page.aspx?o=201982) and the methodology pack{4} specifically developed by the NCC-CC for each chronic condition guideline (http://www.ncgc.ac.uk/). The developers' roles and remit are summarised below.

National Collaborating Centre for Chronic Conditions[2]

The National Collaborating Centre for Chronic Conditions (NCC-CC) was set up in 2001 and is housed within the Royal College of Physicians (RCP). The NCC-CC undertakes commissions received from the NICE.

A multiprofessional partners board inclusive of patient groups and NHS management governs the NCC-CC.

NCC-CC technical team

The technical team met approximately two weeks before each GDG meeting and comprised:

- the GDG group leader
- the GDG clinical advisor
- an information scientist
- a research fellow
- a health economist
- a project manager

[2] In April 2009 the NCC-CC merged with three other national collaborating centres, to form the National Clinical Guideline Centre (NCGC)

- administrative personnel.

Guideline Development Group

The GDG met monthly for 15 months (2004 to 2005) and comprised a multidisciplinary team of professionals, service users, carers and user organisation representatives who were supported by the technical team.

The GDG membership details including patient representation and professional groups are detailed in the GDG membership section in appendix M

(Members of the GDG declared any interests in accordance with the NICE technical manual. A register is available from the NCC-CC for inspection upon request (**ncc-cc@rcplondon.ac.uk**).) (enquiries@ncgc.ac.uk/).

Guideline Project Executive

The Project Executive was involved in overseeing all phases of the guideline. It also reviewed the quality of the guideline and compliance with the DH remit and NICE scope.

The Project Executive comprised:

- the NCC-CC director
- the NCC-CC manager
- an NCC-CC senior research fellow
- the NICE commissioning manager
- the technical team.

Sign-off workshop

At the end of the guideline development process the GDG met to review and agree the guideline recommendations.

2.7 The process of guideline development

There are nine basic steps in the process of developing a guideline.

2006

First step: Developing evidence-based questions

The technical team drafted a series of clinical questions that covered the guideline scope. The GDG and Project Executive refined and approved these questions. See Appendix A for details of the questions.

Second step: Systematically searching for the evidence

The information scientist developed a search strategy for each question. Key words for the search were identified by the GDG. Papers that were published or accepted for publication in peer-reviewed journals were considered as evidence by the GDG. Each clinical question dictated the appropriate study design that was prioritised in the search strategy but the strategy was not limited solely to these study types. Conference paper abstracts and non-English language papers were excluded from the searches. The research fellow identified titles and abstracts from the search results that appeared to be relevant to the question. Exclusion lists were generated for each question together with the rationale for the exclusion. The exclusion lists were presented to the GDG. Full papers were obtained where relevant. See Appendix A for literature search details.

Third step: Critically appraising the evidence

The research fellow or health economist, as appropriate, critically appraised the full papers. In general no formal contact was made with authors however there were *ad hoc* occasions when this was required in order to clarify specific details. Critical appraisal checklists were compiled for each full paper. One research fellow undertook the critical appraisal and data extraction. The evidence was considered carefully by the GDG for accuracy and completeness.

All procedures are fully compliant with the:

- NICE methodology as detailed in the Technical Manual{1}
- NCC-CC Quality Assurance document & Systematic Review paper available at (http://www.ncgc.ac.uk)

2006

Fourth step: Distilling and synthesising the evidence and writing recommendations

The evidence from each full paper was distilled into an evidence table and synthesised into evidence statements before being presented to the GDG. This evidence was then reviewed by the GDG and used as a basis upon which to formulate recommendations.

Evidence tables are available at www.rcplondon.ac.uk/pubs/books/TB/index.asp

Fifth step: Grading the evidence statements and recommendations

The evidence statements and recommendations were graded in accordance with Table 2. The level of evidence and classification of recommendations were also included for diagnostic studies.

Table 2: Hierarchy of evidence and recommendation classification

Levels of evidence		**Classification of recommendations**	
Level	**Type of evidence**	**Class**	**Evidence**
1++	High-quality meta-analysis (MA), systematic reviews (SR) of randomised controlled trials (RCTs), or RCTs with a very low risk of bias.	A	Level 1++ and directly applicable to the target population *or* level 1+ and directly applicable to the target population **AND** consistency of results. Evidence from NICE technology appraisal.
1+	Well-conducted MA, SR or RCTs, or RCTs with a low risk of bias.		
1−	MA, SR of RCTs, or RCTs with a high risk of bias.	Not used as a basis for making a recommendation.	
2++	High-quality SR of case-control or cohort studies. High-quality case-control or cohort studies with a very low risk of confounding, bias or chance and a high probability that the relationship is causal.	B	Level 2++, directly applicable to the target population and demonstrating overall consistency of results *or* extrapolated evidence from 1++ or 1+.
2+	Well-conducted case-control or cohort studies with a low risk of confounding, bias or chance and a moderate probability that the relationship is causal.		
2−	Case-control or cohort studies with a high risk of confounding, bias or chance and a significant risk that the relationship is not causal	Not used as a basis for making a recommendation.	
3	Non-analytic studies (for example case reports, case series).	C	Level 2+, directly applicable to the target population and demonstrating overall

2006

			consistency of results *or* extrapolated evidence from 2++.
4	Expert opinion, formal consensus.	D	Level 3 or 4 *or* extrapolated from 2+ *or* formal consensus *or* extrapolated from level 2 clinical evidence supplemented with health economic modelling.
		D (GPP)	A good practice point (GPP) is a recommendation based on the experience of the GDG.
Diagnostic study level of evidence and classification of recommendation was also included.			

Sixth step: Health economic evidence

Due to the appointment of the health economist midway through the guideline development, the areas for health economic modelling were considered after the formation of the clinical questions. The health economist reviewed the clinical questions to consider the potential application of health economic modelling, and these priorities were agreed with the GDG.

The health economist performed supplemental literature searches to obtain additional data for modelling. Assumptions and designs of the models were explained to and agreed by the GDG members during meetings, and they also commented on subsequent revisions.

Seventh step: Agreeing the recommendations

The sign-off workshop employed formal consensus techniques{1} to:

- ensure that the recommendations reflected the evidence base
- approve recommendations based on lesser evidence or extrapolations from other situations
- reach consensus recommendations where the evidence was inadequate
- debate areas of disagreement and finalise recommendations.

The sign-off workshop also reached agreement on the following:

- seven key priorities for implementation
- eight key research recommendations
- five algorithms.

2006

In prioritising key recommendations for implementation, the sign-off workshop also took into account the following criteria:

- high clinical impact
- high impact on reducing variation
- more efficient use of NHS resources
- allowing the patient to reach critical points in the care pathway more quickly.

The audit criteria provide suggestions of areas for audit in line with the key recommendations for implementation.

Eighth step: Structure of the full version of the guideline

The guideline is divided into sections for ease of reading. For each section the layout is similar and is described below:

The clinical introduction sets a succinct background and describes the current clinical context.

The methodological introduction describes any issues or limitations that were apparent when reading the evidence base.

Evidence statements provide a synthesis of the evidence base and usually describe what the evidence showed in relation to the outcomes of interest.

Health economics presents an overview of the cost-effectiveness evidence base of relevance to the area under address.

'From evidence to recommendations' highlights the debate of the GDG. This section sets out the GDG decision-making rationale, providing a clear and explicit audit trail from the evidence to the evolution of the recommendations.

The recommendations section provides stand-alone, action-orientated recommendations.

Evidence tables are not published as part of the full guideline but are available online at www.rcplondon.ac.uk/pubs/books/TB/index.asp. These describe comprehensive details of the primary evidence that was considered during the writing of each section.

Ninth step: Writing the guideline

The first draft version of the guideline was drawn up by the technical team in accord with the decision of the GDG. The guideline was then submitted for two formal rounds of public and stakeholder consultation prior to publication. The registered stakeholders for this guideline are detailed at the NICE website (www.nice.org.uk). Editorial responsibility for the full guideline rests with the GDG7.

Table 3 describes the various versions of the guideline that are available.

Table 3: Versions of this guideline

Versions	Comments
Full version	Details the recommendations. The supporting evidence base and the expert considerations of the GDG. Available at www.rcplondon.ac.uk/pubs/books/TB/index.asp
NICE version	Documents the recommendations without any supporting evidence. Available at www.nice.org.uk/page.aspx?o=guidelines.completed
Quick reference guide	An abridged version. Available at www.nice.org.uk/page.aspx?o=guidelines.completed
Information for the public	A lay version of the guideline recommendations. Available at www.nice.org.uk/page.aspx?o=guidelines.completed

2.8 Healthcare needs assessment

In contrast to many NICE guidelines, the scope requires service guidance in the prevention and control chapters of this guideline (chapters 11–13) and for rapid diagnostic techniques (sections 5.3 and 5.4). The NCC-CC conducted a rapid and simple healthcare needs assessment in order to establish current practice and resources, and to identify areas where these did not match the clinical need. This collected information through a review of the epidemiology of TB in England and Wales, and a review of current service by questionnaire among a sample of TB service providers.

Review of epidemiology

At the outset of the guideline development the prevention and control research fellow, Dr Ian Lockhart, compiled epidemiological data relevant to England and Wales from a number of national sources into a report to inform GDG discussions. This was refined through discussion at GDG meetings, is presented in this guideline in the Appendix G and in section 4.2, and will be described in a forthcoming paper.

Survey of current services

The NCC-CC sought information on current service provision in terms of staffing, location of specific services and caseload. Dr Sooria Balasegaram coordinated this survey through TB nurses and the Health Protection Agency's local and regional services. Further details are given in section 4.2 and will be described in a forthcoming paper.

2006

2.9 Funding

The National Collaborating Centre for Chronic Conditions was commissioned by the National Institute for Health and Clinical Excellence to undertake the work on this guideline.

2.10 Methodology – 2011

The Department of Health formally asked NICE to produce a short clinical guideline on interferon-gamma testing for diagnosing latent TB.

The following population subgroups were considered:

- Adults, young people and children at increased risk of infection by Mycobacterium tuberculosis complex (M. tuberculosis, M. africanum, M. bovis), specifically if they:
  - have arrived or returned from high-prevalence countries within the last 5 years
  - were born in high-prevalence countries
  - live with people diagnosed with active TB
  - have close contact with people diagnosed with active TB, for example at school or work

New 2011

  - are homeless or problem drug users
  - are, or have recently been, in prison.
- Adults and children who are immunocompromised because of:
  - prolonged steroid use (equivalent to 15 mg prednisolone daily for at least 1 month)
  - TNF-α antagonists such as infliximab and etanercept
  - anti-rejection drugs such as cyclosporin, various cytotoxic treatments and some treatments for inflammatory bowel disease, such as azathioprine
  - the use of immunosuppressive drugs
  - comorbid states affecting the immune system, for example HIV, chronic renal disease, many haematological and solid cancers, and diabetes.

New 2011

The updated sections of this guideline were developed in accordance with the process for short clinical guidelines set out in 'The guidelines manual' (2009) (see www.nice.org.uk/GuidelinesManual). There is more information about how NICE clinical guidelines are developed on the NICE website (www.nice.org.uk/HowWeWork). A booklet, 'How NICE clinical guidelines are developed: an overview for stakeholders, the public and the NHS' (fourth edition, published 2009), is available from NICE publications (phone 0845 003 7783 or email publications@nice.org.uk and quote reference N1739).

2.11 Partial update scope

The guideline was developed in accordance with a specified scope, which detailed the remit of the guideline originating from the Department of Health (DH) and specified those aspects of TB to be included and excluded.

Before development of the guideline began, the scope was subjected to stakeholder consultation. The scope is given in Appendix F

2.12 Partial update Guideline Development Group

The GDG met every 6 weeks over a 5-month period from February until June 2010. The group comprised a multidisciplinary team of professionals, patients and carers who were supported by the technical team.

The GDG membership details can be found in appendix N.

Members of the GDG declared any interests in accordance with the NICE guidelines manual. These can be found in appendix N.

2.13 Updating the guideline

NICE clinical guidelines are updated so that recommendations take into account important new information. New evidence is checked 3 years after publication, and healthcare professionals and patients are asked for their views; we use this information to decide whether all or part of a guideline needs updating. If important new evidence is published at other times, we may decide to do a more rapid update of some recommendations. Please see our website for information about updating the guideline.

For the sections published in 2006 literature searches were repeated for all of the evidence-based questions at the end of the GDG development process allowing any relevant papers published up until 30 November 2004 to be considered. For the section on the diagnosis of latent TB published in 2011 literature searches were not repeated because the development process was only a few months long. The section on diagnosing latent TB includes relevant papers published up until December 2009.

New 2011

Disclaimer

Healthcare providers need to use clinical judgement, knowledge and expertise when deciding whether it is appropriate to apply guidelines. The recommendations cited here are a guide and may not be appropriate for use in all situations. The decision to adopt any of the recommendations cited here must be made by the practitioner in light of individual patient circumstances, the wishes of the patient, clinical expertise and resources.

2006

The British National Formulary (BNF){5} should be consulted alongside any drug recommendations cited in this guideline and note taken of the indications, contraindications, cautions and product characteristics.

NICE guidelines will normally only make drug recommendations that fall within licensed indications. If a drug is recommended outside of its licensed indication this will be made clear in the guideline. This guideline contains recommendations for prescribing the following, all of which are within current licensed indications:

- ethambutol, for treating active tuberculosis
- isoniazid, for treating both latent and active tuberculosis
- pyrazinamide, for treating active tuberculosis
- rifampicin, for treating both latent and active tuberculosis
- streptomycin, for treating isoniazid mono-resistant active TB
- any glucocorticoid, for treating inflammation associated with active tuberculosis of the meninges or central nervous system (CNS).

The NCC-CC and NICE disclaim any responsibility for damages arising out of the use or non-use of these guidelines and the literature used in support of these guidelines.

2006

3 Key messages of the guideline

3.1 Key priorities for implementation

A six-month, four-drug initial regimen (six months of isoniazid and rifampicin supplemented in the first two months with pyrazinamide and ethambutol) should be used to treat active respiratory TB[3] in:

- adults not known to be HIV positive A
- adults who are HIV positive B
- children. B

This regimen is referred to as the 'standard recommended regimen' in this guideline.

Patients with active meningeal TB should be offered:

- a treatment regimen, initially lasting for 12 months, comprising isoniazid, pyrazinamide, rifampicin and a fourth drug (for example, ethambutol) for the first two months, followed by isoniazid and rifampicin for the rest of the treatment period D(GPP)
- a glucocorticoid at the normal dose range
  – adults: equivalent to prednisolone 20–40 mg if on rifampicin, otherwise 10–20 mg A
  – children: equivalent to prednisolone 1–2 mg/kg, maximum 40 mg D(GPP)

with gradual withdrawal of the glucocorticoid considered, starting within 2–3 weeks of initiation.

Use of directly observed therapy (DOT) is not usually necessary in the management of most cases of active TB. A

All patients should have a risk assessment for adherence to treatment, and DOT should be considered for patients who have adverse factors on their risk assessment, in particular:

2006

[3] TB affecting the lungs, pleural cavity, mediastinal lymph nodes or larynx.

- street- or shelter-dwelling homeless people with active TB B
- patients with likely poor adherence, in particular those who have a history of non-adherence. D(GPP)

The TB service should tell each person with TB who their named key worker is, and how to contact them. This key worker should facilitate education and involvement of the person with TB in achieving adherence. D(GPP)

New entrants[4] should be identified for TB screening from the following information:

- port of arrival reports D(GPP)
- new registrations with primary care B
- entry to education (including universities) D(GPP)
- links with statutory and voluntary groups working with new entrants. D(GPP)

Neonatal Bacille Calmette-Guèrin (BCG) vaccination for any baby at increased risk of TB should be discussed with the parents or legal guardian. D(GPP)

Primary care organisations with a high incidence of TB[5] should consider vaccinating all neonates soon after birth. D(GPP)

2006

[4] New entrants are defined as people who have recently arrived in or returned to the UK from high-incidence countries, with an incidence of more than 40 per 100,000 per year, as listed by the Health Protection Agency (go to www.hpa.org.uk and search for 'WHO country data TB').
[5] Incidence of more than 40 per 100,000, as listed by the Health Protection Agency; go to www.hpa.org.uk and search for 'tTB rate bands'

3.2 Algorithms

The following algorithms appear in this document:

- algorithm showing isolation decisions for patients with suspected TB (*see* Figure 2)
- algorithm for testing and treating asymptomatic children aged between four weeks and two years old who are contacts of people with sputum smear-positive TB (*see* Figure 10)
- algorithm for asymptomatic household and other close contacts of all cases of active TB (*see* Figure 11).
- algorithm for new entrant screening (*see* Figure 12)
- algorithm for new NHS employees (*see* Figure 13).

2006

3.3 Audit criteria

Table 4: Audit criteria

Key priority for implementation	Criteria	Exception	Definition of terms
A six-month, four-drug initial regimen (six months of isoniazid and rifampicin supplemented in the first two months with pyrazinamide and ethambutol) should be used to treat active respiratory TB in: • adults not known to be HIV positive A • adults who are HIV positive B • children. B This regimen is referred to as 'standard recommended regimen' in this guideline.	a) Process measure: percentage of patients with active TB receiving rifampicin, isoniazid, pyrazinamide and ethambutol (or other fourth drug) for the first two months of treatment. b) Outcome measure: percent cure and completion rate.	Contraindications, meningeal TB, CNS involvement, drug resistance.	
Patients with active meningeal TB should be offered:	a) Process measure: percentage of	Contraindications, drug resistance.	b) Any patient who received glucocorticoids for

2006

• a treatment regimen, initially lasting for 12 months, comprising isoniazid, pyrazinamide, rifampicin and a fourth drug (for example, ethambutol) for the first two months, followed by isoniazid and rifampicin for the rest of the treatment period D(GPP) • a glucocorticoid at the normal dose range • adults – equivalent to prednisolone 20–40 mg if on rifampicin, otherwise 10–20 mg A • children – equivalent to prednisolone 1–2 mg/kg, maximum 40 mg D(GPP) with gradual withdrawal of the glucocorticoid considered, starting within two to three weeks of initiation.	patients with meningeal TB receiving rifampicin, isoniazid, pyrazinamide and ethambutol (or other fourth drug) for the first two months of treatment. b) Process measure: percent receiving/having received glucocorticoids. c) Outcome measure: percent cure and completion rate (12 months).		at least two weeks.	2006

Use of DOT is not usually necessary in the management of most cases of active TB. A All patients should have a risk assessment for adherence to treatment, and DOT should be considered for patients who have adverse factors on their risk assessment, in particular: a) street- or shelter-dwelling homeless people with active TB B b) patients with likely poor adherence, in particular those who have a history of non-adherence. D(GPP)	Process measure: percentage of patients with active TB who are treated with DOT.		A 'patient on DOT' is any patient who has been prescribed anti-TB drugs as directly observed therapy (regardless of observer) for part or all of their treatment.	2006
The TB service should tell each person with TB who their named key worker is, and how to contact them. This key worker should facilitate education and involvement of the person with TB in achieving adherence. D(GPP)	Process measure: percentage of TB patients in possession of current correct key worker's details.	Hospital inpatients.	Key worker will have been named as specified in recommendations.	

New entrants should be identified for TB screening from the following information: • port of arrival reports D(GPP) • new registrations with primary care B • entry to education (including universities) D(GPP) • links with statutory and voluntary groups working with new entrants. D(GPP)	a) Process measure: percentage of new entrants referred or recorded who are contacted for screening. b) Process measure: percent of new entrants contacted for screening, who complete the screening. c) Process measure: percent of new entrants contacted for screening, who are referred to secondary care TB teams.	a) Any people sought but not found. b) Any people sought but not found. Loss to follow-up, including not returning for Mantoux test to be read, chest X-ray to be taken, treatment for latent TB infection to be started, etc.	b) Any person who completes the screening process according to the algorithm is counted.	2006

Neonatal BCG vaccination for any baby at increased risk of TB should be discussed with the parents or legal guardian. D(GPP) Primary care organisations with a high incidence of TB[6] should consider vaccinating all neonates soon after birth. D(GPP)	a) Process measure: percentage of neonates vaccinated with BCG. b) Process measure: percentage of eligible neonates vaccinated with BCG.	Informed refusal, HIV.	2006

[6] As defined by the Health Protection Agency; go to www.hpa.org.uk and search for 'tuberculosis rate bands'

4 Aims and principles of tuberculosis care

In 2005, the Chief Medical Officer's TB Action Plan, *Stopping tuberculosis in England,*{2} set out essential tasks for reversing the increase in tuberculosis incidence and ensuring high-quality care and public health. The very first task in the action plan is the production and wide availability of information and educational materials on tuberculosis, and it specifies that they should be 'multi-lingual and culturally appropriate'. The GDG enthusiastically support this, and therefore this guideline recommends the availability of such information and materials throughout the NHS, tailored to meet the needs of different languages and cultures.

As part of the action for 'excellence in clinical care', the action plan calls for a named key worker assigned to every patient, and that they should work closely with other agencies such as housing and social services to achieve improved outcomes. The GDG acknowledged the great importance of achieving a care plan which makes the successful completion of treatment of active or latent TB as easy as possible for the person receiving the treatment, and so this guideline has provided recommendations to support these aims and those of the Chief Medical Officer.

Where scientific evidence supports it, the parts of this guideline addressing prevention and control (chapters 11–13) include recommendations for aspects of service organisation as well as for individual teams of healthcare professionals. The guideline attempts to focus NHS resources where they will effectively combat the spread of TB, and in some sections deals with high- and low-incidence areas separately.

The GDG acknowledge the importance of honest and positive communication concerning TB in overcoming stigma, poor concordance and misinformation about the condition and recognising socio-economic factors. Healthcare teams caring for people with, or at risk from, TB will need to work with non-NHS agencies to ensure a seamless service that promotes detection, concordance and cure.

2006

4.1 Current service organisation

The review of current services (see Appendix G for more details) identified four basic service models in use.

Centralised

In this model TB nurses are based in a central unit, usually the health protection unit (HPU), and are responsible for all TB services including contact tracing and screening in a defined area. This model is used in areas with high and low incidence. It allows all TB services in the area to be coordinated and standardised. A variant which resembles the specialist hospital-based model (see below) is seen in some low-incidence small geographical areas, where a few nurses based in local hospitals or community clinics can achieve high volumes of specialisation.

Central with satellites

This is a variation of the first model; there are nurses at HPU level and other clinics alongside such as specialist new entrant and screening clinics. It may include generalist clinics in hospitals. In some cases the HPU nurse may coordinate all TB services, including contact tracing using satellite clinics. In this model, the HPU nurse may identify and send individuals for contact tracing to non-specialist health visitors in the community. It allows for coordination of services in areas of large geographical distance.

General hospital/community model

General respiratory nurses see people with TB in this model, sometimes with an additional nurse led clinic for contact tracing, BCG or new entrant screening. This model is used in areas of lowest incidence. Nurses may also be based in the community, and may run screening clinics.

Specialist hospital-based model

TB nurses are based in clinics in local hospitals or specialist community screening units but have functions for the surrounding community. There may a larger HPU-based network connecting these nurses. This model is seen in London and other areas with a relatively high TB incidence.

Staffing levels

The review aggregated staffing levels across HPUs to account for apparent imbalances between different types of clinic within each local area. The scatter plot of notifications against whole time equivalent (WTE) nursing staff (Figure 1) shows a clear correlation (Spearman's ρ =0.85), which is perhaps an indication that services are now in line with the British Thoracic Society (BTS) code of practice's{6} recommendations. These stated that nursing staff should be maintained at one WTE nurse (or health visitor) per 50 notifications per year outside London, and 40 per year in London. The review reflects a development in TB services since the audit conducted in 1999.{7} However, notification rates continue to increase in England and Wales, and it would seem that the challenge for those planning TB services is to see this increase in resources targeted effectively at those activities for which the evidence demonstrates benefit. This guideline aims to inform those decisions wherever possible.

Across HPUs, the WTE rate is roughly 1 per 40 notifications. London HPUs have the highest caseload and hence the highest WTE.

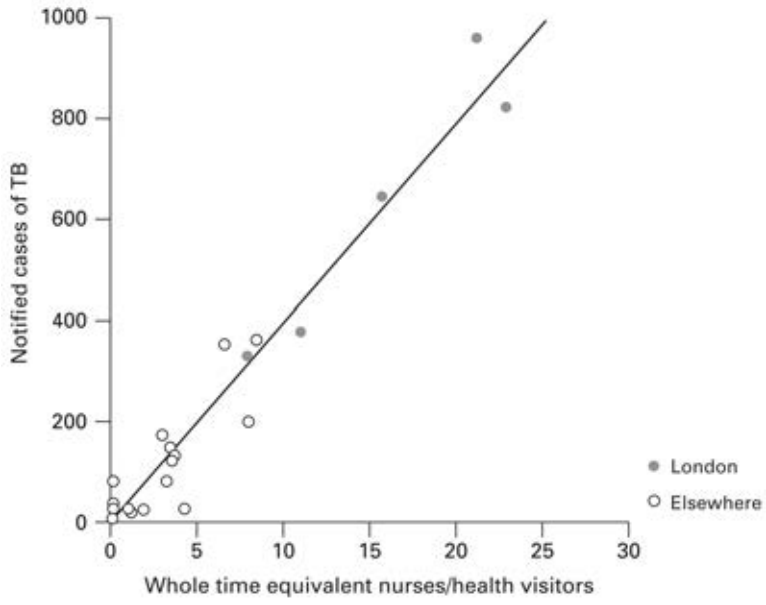


Figure 1: Staffing levels of nurses/health visitors vs notified cases of TB. The line represents one whole time equivalent per 40 cases

2006

Other information on current services

The following aspects of the review of current services are reported in this guideline (details of the methods employed are given in Appendix G):

- dedicated TB clinics (section 6.1)
- nurse-led follow-up clinics (section 6.1)
- specialist HIV/TB clinics (section 6.1)
- specialist paediatric TB clinics (section 6.1)
- directly Observed Therapy (DOT) (section 8.2)
- free prescriptions (section 8.3)
- measures to improve adherence (section 8.3)
- outreach (section 8.3)
- incentives for attending clinic (section 8.3)
- treatment of latent TB infection (sections 10.2 and 12.2)
- negative pressure facilities (section 9.3)
- BCG clinics (section 11)
- neonatal BCG (section 11.1)
- high risk group screening (section 12)
- contact tracing clinics (section 12.2)
- *Mycobacterium bovis* (section 12.3)
- specialist new entrants clinics (section 12.7)
- prison services (section 13.3).

4.2 Communication and patient information

During the development of the guideline, patient and carer representatives on the GDG highlighted these suggestions:

- a single national source of high-quality TB information in relevant languages, and formats for vision- or hearing-impaired people
- TB services to assess local language and other communication needs, and accordingly make information from the national source available locally

- clear discussion between healthcare professionals, people with (or at risk from) TB and their carers about tests, treatment, contact tracing and infection control measures, to enable understanding
- people with both HIV and TB to be provided with information about the different specialties who may provide care during and after their treatment for TB
- contact tracing explained and handled sensitively to avoid misunderstanding and stigma
- information set out so as not to medicalise the patient
- TB services providing each patient completing anti-tuberculosis treatment with clear ‘inform and advise’ information

The first task for improving TB services to be named in the Chief Medical Officer’s TB Action Plan{2} is to ‘produce multilingual and culturally appropriate public information and education materials for national and local use and make them widely available’. See also section 2.5 above, for details of the National Knowledge Service.

Communication and information provision are an important part of efforts to successfully reverse the increase in TB incidence in England and Wales. Information resources for TB address the following aims:

- achieving earlier diagnosis through general public awareness of symptoms
- combating stigma and myths, which may delay presentation and impede contact tracing
- helping to achieve concordance and treatment completion through awareness of different treatment options, awareness of side effects, and the importance of adhering to the treatment regimen
- relieving anxiety about infection control measures in healthcare settings, family life and the workplace.

Recommendations are therefore given under section 6.2.

2006

4.3 HIV co-infection

2006

This guideline discusses risk assessments for HIV, and gives recommendations for treatment of active and latent TB in co-infected people. However, the specialised guidelines in the UK, at the time of going to press, are those from the British HIV Association,{8} and readers should be aware of these when considering care of any patient who is known to be, or is possibly, co-infected.

The Guideline: Diagnosis and Treatment

5 Diagnosis

5.1 Diagnosing latent tuberculosis

5.1.1 Clinical introduction

In asymptomatic persons exposure to, and potential infection with, tuberculosis is demonstrated by a positive skin test, or more recently from a positive blood-based immunological (interferon-gamma) test. Those with a strongly positive skin test are then regarded as having been infected with tuberculosis. Of these people presumed infected, there is a 10–15% chance of developing clinical disease at some point in their lives. If a co-morbidity develops which reduces the immune system (see section 10.2), that risk is increased. The majority of exposed persons will kill off the inhaled bacteria, and be left only with a positive skin test as a marker of exposure. About half of those who develop the clinical disease will do so within five years of the initial infection. In cases where a long period elapses between infection and development of disease, dormant bacilli are thought to remain in either the lung or other sites, which can 'reactivate' in favourable circumstances for the organism.

Until recently, only Mantoux tests were available to give evidence of exposure. The tuberculin tests had the advantage of being cheap and relatively easy to perform, but suffered from a number of problems. The test results have to be interpreted within a certain timescale, and patients who do not return, or delay returning, will have either no result or a possibly inaccurate one. False positive results can occur because of the sensitising effect on the immune system of either prior BCG vaccination or opportunist environmental mycobacteria. False negative results can occur due to anything reducing immunity, particularly co-infection with HIV, but also treatments such as cytotoxics, or immunosuppression. Extensive tuberculosis (pulmonary or miliary) can itself also temporarily depress the immunity, and can lead to a paradoxically negative Mantoux tests. More recently, selective immunological

(interferon-gamma) tests have been developed using the tuberculosis antigens 'early secretion antigen target 6′ (ESAT-6) , 'culture filtrate protein 10′ (CFP-10) and tb7.7, which are not present in BCG, and are found in only a few species of environmental mycobacteria. These can be done on either cells or cell products derived from whole blood tests. These tests aim to be more specific by removing false positive results, and to be better correlated with latent infection or dormant organisms.

2006

5.1.2 Methodological introduction

2006, amended 2011

Because there is now additional evidence available on the use of IGT, the partial update of CG33 sought to make recommendations on the use of IGT for diagnosis of latent TB.

There are currently three interferon-gamma immunological tests commercially available for use in the UK: QuantiFERON-TB Gold, QuantiFERON-TB Gold In tube and T-SPOT.*TB*. QuantiFERON-TB Gold measures the release of interferon-gamma in whole blood in response to stimulation by ESAT-6 and CFP-10 which are not present in BCG vaccine strains or the vast majority of non-TB mycobacteria. The In tube version measures ESAT-6, CFP-10 and tb7.7 In the T-SPOT.*TB* test, individual activated ESAT-6 and CFP-10 specific T-cells are enumerated using ELISPOT methodology

In order to make appropriate recommendations, review questions were framed according to the following population groups: adults young people and children from high incidence countries, adults, young people and children who had been in contact with individuals with active TB, or immunocompromised individuals. Children were treated as a separate population because they have a less developed immune system than adults, and the mechanism of action of the tests relies on a fully developed immune system.

The key clinical questions considered were:

1. Which diagnostic strategy is most accurate in diagnosing latent TB in adults, young people and children who are recent arrivals from high prevalence countries?

2. Which diagnostic strategy is most accurate in diagnosing latent TB in children?

3. Which diagnostic strategy is most accurate in diagnosing latent TB in adults, young people and children (children considered as a separate population) who have been in close contact with patients with active TB?

4. Which diagnostic strategy is most accurate in diagnosing latent TB in immunocompromised patients?

5. What is the effectiveness of screening using IGT for healthcare workers?

The review protocol is included in appendix B.

A search strategy was used which aimed to identify relevant studies for all the review questions. The following databases were searched: Cochrane database of systematic reviews (CDSR), Database of Abstracts of Reviews of Effects (DARE), Health technology assessment (HTA) database, Medline, Embase, Cinahl, NHS Economic Evaluation database (NHS EED). Trial registers such as Cochrane central register of controlled trials (CENTRAL), UKCRN Portfolio database, current controlled trials, clinicaltrials.gov were searched. Websites of relevant organisations such as World Health Organisation and TB alert were also searched. No methodology search filters or publication date filters were used. A total of 5270 studies were identified for the whole review. After sifting by abstract, 467 studies were selected (n = 56, 70, 69 ,153 and 5 for questions 1 to 5 respectively).

Studies were excluded if they**:**

- did not compare Mantoux tests with IGT
- evaluated IGT based on purified protein derivative
- did not focus on latent TB
- focused on treatment of TB
- focused on non commercial IGT or in-house IGT.

The detailed evidence tables for the included studies and list of excluded papers and reasons for exclusion are given in appendices O and J.

There were methodological issues with the included papers. For example, active TB was not always excluded (either through investigation or not reported), there was repeated testing of both Mantoux and IGTs, the threshold for positive Mantoux tests varied, and it was not clear whether the use of cut-offs was always age appropriate. If identified, these issues were used to downgrade the quality of the evidence in the GRADE tables.

Diagnostic accuracy studies considered as high quality are those where the index test(s) are compared with a recognised, validated reference standard. Measures of accuracy, when compared with the reference test, such as sensitivity and specificity can then be determined. The Mantoux test has been the preferred test in clinical practice for several years but it is not an ideal reference standard; for example, the specificity of the Mantoux test is confounded by BCG vaccination. This implies false-positive results could be seen in this group of people because the Mantoux test is not able to distinguish between individuals who actually have the infection, and those who have been vaccinated with BCG. Because of such concerns about the Mantoux test as a reference standard, other measures of effect such as discordance, concordance and odds ratios are used. These measure the association between the results of the test(s) and the risk of having latent TB, but do not give any information on rates of false positives or negatives.

In addition, the GRADE methodology has not been fully developed for diagnostic studies. A modified form of GRADE was used to assess the quality of evidence found. Standard GRADE profiles for interventions use the following criteria to assess quality of evidence: limitations, inconsistency, imprecision and indirectness. In this review the same criteria were applied. Footnotes have been included to define and describe what the criteria mean in the context in which the studies were analysed. It was not possible to measure imprecision so this has been noted as ‘not measurable’ in the tables. This is because guidance has not yet been developed to address thresholds for imprecision for the measures of effect that were determined. These

measures of effect did not appropriately describe the effectiveness of the diagnostic tools. Therefore, the GDG were not asked to agree a pre-defined threshold for imprecision. For questions on children and contact tracing it was possible to pool the ratio of odds ratios and to perform a meta analysis. The ratio of odds ratios is a measure of effect which reflects test performance and provides an approach to evaluating tests in the absence of a reference test. The odds ratio (OR) is a function of test sensitivity and specificity and increases as one or both of these measures increase. Statistically OR = [sensitivity/(1-specificity)]/[(1-sensitivity)/specificity].

The spreadsheets used to calculate and determine the risk categories as defined by level of exposure to active TB are given in appendices P and Q.

The main aim of this update was to review diagnosis of latent TB using tests for which there is no ideal reference standard for comparison. One important objective was to identify appropriate measures of effect to assess the diagnostic utility of the tests. Different approaches were taken to address this objective.

- Discordance and concordance between the IGT and Mantoux tests were measured in some of the papers. There were few prospective studies to identify participants who would either develop active TB following a positive test result or stay healthy following a negative test result. These studies are designed to determine positive and negative predictive values. For diagnosis of latent TB this type of design would give the most accurate prognosis predicting those who will get active TB and those who would not.
- In other studies the odds of a positive test associated with graded exposure to an active TB case were measured. In these cases a proxy measure of effect, the ratio of odds ratios could be calculated if figures of positive test results of study participants were clearly stated, and where the exposure status of those participants had been identified. The main disadvantage of this proxy measure is that it fails to identify whether the good performance of a test compared with another is because of either

better sensitivity, specificity or both. It is impossible therefore to determine the false positive and false negative rates of a particular test.

5.1.3 Partial update health economics introduction

The following sections outline the updated modelling for two populations identified in the scope: adult contacts (including health care workers) and screening people from high prevalence countries. However, because of an absence of evidence, no cost-effectiveness analysis was conducted for all child and young people populations. Because of an absence of information no new distinct analysis was conducted for screening new NHS employees and the immunocompromised population. For children, the almost complete absence of sensitivity and specificity information and quality of life data meant that a useful analysis could not be produced. For the two remaining adult populations the results of the other two analyses will be extrapolated to these situations

A search for cost-effectiveness studies identified five relevant papers that examined the use of IGT in screening people from high prevalence countries with suspected latent TB infection, and one relevant paper that examined the use of IGT in the adult contacts and healthcare workers contacts with suspected latent TB infection. The papers were reviewed with quality checklists to assess their applicability and limitations. A completed checklist is available in annex 6 in appendix L. None of the papers were considered applicable to the decision problem either because they were not based in the UK or did not include consideration of quality of life. However cost-effectiveness papers were used to explore approaches to modelling strategies and to inform the structure of the model.

A decision model based on the previous guideline was used to compare the expected cost effectiveness of four strategies of testing for latent infection in both adult (aged more than 18 years) populations described above. The strategies compared were:

- Mantoux test

- IGT
- Mantoux test followed by IGT
- no test.

In the model, treatment follows current policy; with appropriate therapy for people diagnosed with active and latent TB. The analysis did not compare different types of skin tests or IGTs because this was outside the scope of this guideline.

The key areas that were updated were the test accuracies and the relevant costs. All costs were updated to current prices and were validated by the GDG. The test accuracies were based on published reviews which calculated sensitivities and specificities again after validation by the GDG.

The assumptions made in the initial guideline were still applicable unless stated otherwise. Whenever possible, input parameters and assumptions were based on empirical evidence, but some key parameters were estimated by the health economist and GDG. The model considers the quality-adjusted life years (QALYs) lost because of infection, adverse events and developing TB. Therefore, the interventions with the smallest QALY loss are the most effective. Throughout the analysis incremental cost-effectiveness ratios (ICERs) will be compared with a common base line (usually no test) and net monetary benefits will be calculated. Net monetary benefit quantifies which treatment option provides the greatest health benefit for a given threshold. A threshold of £20,000 per QALY gained was used in this analysis. Probabilistic sensitivity analysis was considered, however some of the estimates of the means of variables were assumptions and it was therefore considered more instructive to do a series of one way sensitivity analysis rather than a probabilistic sensitivity analysis.

For each population details were given on the source of the new test accuracy data with base-case results and sensitivity analyses.

5.1.4 Diagnosis of latent TB in people who are recent arrivals from countries where TB is highly prevalent

Key clinical question

Which diagnostic strategy is most accurate in diagnosing latent TB in adults and children who are recent arrivals from highly prevalent countries?

Evidence review

Of the ten studies included:

- three were conducted in Germany (Diel et al. 2006; Diel et al. 2008; (Anon)
- two in the Netherlands (Franken et al. 2007; Kik et al. 2009)
- two in the United States (Brodie et al. 2008; Porsa et al. 2006)
- one in Italy (Carvalho et al. 2007)
- one in Norway (Winje et al. 2008)
- one in Switzerland (Janssens et al. 2008).

All studies looked at participants from high prevalence countries from places such as sub Saharan Africa, Central and South America, Eastern Europe and Asia.

The main measures of effect used were:

- concordance and discordance between tests
- agreement between the tests as measured by kappa values
- odds ratios

- ratio of odds ratios (ROR). In this guideline ROR is mathematically defined as (odds of positive IGT in a high-risk area divided by the odds of a positive test in a low-risk area) divided by (odds of a positive Mantoux test in a high-risk area divided by a positive Mantoux test in a low-risk area)

Table 5 Diagnosis of latent TB infection in foreign-born people and in people arriving from high-prevalence countries

Study[1]	Population group (by prevalence or place of birth or racial group)	Odds ratio (Mantoux test ≥ 5 mm)	Odds ratio (Mantoux test ≥ 10 mm)	Odds ratio (Mantoux test ≥ 15 mm)	Odds ratio (IGT)	ROR	Limitations	Inconsistency	Indirectness	Imprecision	Other Considerations	Quality	2006, amended 2011
Janssens et al. (2008)	< 50 per 100,000	1	1	–	1	–	Y	Y	N	-	N	Low	
	50–99 per 100,000	2.58 (1.26 to 5.27)	2.22 (1.15 to 4.27)	–	2.17 (1.13 to 4.15)	0.98							
	> 100 per 100,000	3.67 (1.40 to 9.60)	3.84 (1.61 to 9.20)	–	2.62 (1.18 to 5.82)	0.68							
Diel et al. (2008)	Germany	1	1	–	1	–	Y	N	N	-	N	Low	
	Not Germany	5.81 (3.6 to 9.1)	5.2 (3.2 to 8.4)	–	2.28 (1.3 to 3.9)	0.438							
Nienhaus et al. (2008)	Germany (< 6 per 100,000)	–	1	–	1	–	N	N	N	-	N	Low	
	Not Germany (> 20 per 100,000)	–	4.6 (3.21 to 6.53)	–	2.6 (1.71 to 4.09)	0.565							
Diel R et al. (2006)	Germany (< 6 per 100,000)	1	1	–	1	–	Y	N	N	-	N	Low	
	Not Germany (> 20 per 100,000)	5.4 (2.7 to 10.6)	7.3 (3.7 to 14.3)	–	4.7 (2.1 to 10.5)	0.644							
Porsa et al. (2006)	USA (< 10 per 100,000)	–	1	–	1	–	Y	N	N	-	N	Low	
	Not USA (25–300 per 100,000)	–	20.20 (4.21 to 79.02)	–	2.86 (0.67 to 12.15)	0.141							

Study[1]	Population group (by prevalence or place of birth or racial group)	Odds ratio (95%CI) Mantoux test ≥ 5 mm	Odds ratio (95%CI) Mantoux test ≥ 10 mm	Odds ratio (95%CI) Mantoux test ≥ 15 mm	Odds ratio (95%CI) IGT	ROR	Limitations	Inconsistency	Indirectness	Imprecision	Other Considerations	Quality
Kik et al. (2009)	Asia		1		1		Y	N	Y	-	N	Low
	Europe, North America		1.69 (0.44 to 6.45)		QFT = 0.48(0.17 to 1.36); TSPOT = 0.35(0.13 to 0.99)							
	Sub-Saharan Africa		6.00 (1.32 to 27.24)		QFT = 2.97 (1.40 to 6.27); TSPOT 2.40 (1.13 to 5.10)							
Winje et al. (2008)	Asia			1	1		Y	N	Y	-	N	Low
	Europe			2.7 (1.5 to 4.9)	1.0 (0.6 to 1.6)							
	Africa			3.8 (2.4 to 5.8)	3.1 (2.2 to 4.2)	0.82						
Porsa et al. (2006)	CaucasianWhite		1		1		Y	N	N	-	N	Low
	African-Caribbean		4.97 (1.58 to 15.68)		5.57 (1.16 to 26.74)	1.12						

[1] Outcomes were diagnostic utility and threshold value for a positive diagnosis of latent TB.

[2] Odds Ratio for a positive test in people who are foreign-born or from high endemic areas adjusted for BCG vaccination, age, gender and exposure time.

Limitations were the lack of a reference test means the measures of effect of sensitivity and specificity cannot be determined. Inconsistencies were different studies used different types of Mantoux test. Imprecision was not measurable.

CI = confidence interval. IGT = inferferon gamma test. ROR = ratio of odds ratios. QFT = QuantiFERON-TB interferon gamma test. TB = tuberculosis. TSPOT = T-SPOT.TB interferon gamma test

2006, amended 2011

	OVERALL						BCG VACCINATED						NON BCG VACCINATED												2006, amended 2011
	Induration						Induration						Induration						Limitations	Inconsistensy	Indirectness	Imprecision	Other Considerations	Quality	
Studies	5 mm		10 mm		15 mm		5 mm		10 mm		15 mm		5 mm		10 mm		15 mm								
	Concordance	kappa	Concordance	kappa	Concordance	kappa	Concordance	kappa	Concordance	kappa	Concordance	kappa	Concordance	kappa	Concordance	kappa	Concordance	kappa							
Porsa et al. 2006	90 %(87–93 %)	0.25(0.1–0.41)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	Y	N	N	-	N	very low	
Franken et al. 2007	ND	ND	82%	0.19	92.30 %	0.24	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	Y	N	N	-	N	very low	
Carvalho et al. 2007	ND	ND	71%	0.37	ND	ND	ND	ND	0.28(0.10–0.77)a OR	ND	ND	ND	ND	ND	ND	ND	ND	ND	Y	N	N	-	N	Low	
Brodie et al. 2008	64 %(54–74 %)	0.33 (0.19–0.48)	ND	ND	ND	ND	56% (43–68)	0.22 (0.06–0.37)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	Y	N	Y	-	Y	very low	

Janssens et al. 2008	60.70 %	0.24(0.14–0.33)	63.60%	0.27(0.16–0.38)	63.90 %	0.19(0.09–0.30)	ND	ND	ND	ND	ND	ND	78.40 %	0.47(0.20–0.74)	76.50 %	0.41(0.14–0.68)	78.40 %	0.28(0.03–0.54)	N	N	N	-	Y	Low
Nienhaus et al. 2008	74.80 %	0.26	84.20%	0.37	89.80 %	0.33	ND	0.12	ND	0.28	ND	ND	ND	0.5	ND	0.54	ND	0.3	N	N	N	-	Y	Low
Diel et al. 2006	ND	ND	ND	ND	ND	ND	38.90%	0.08	77.10 %	0.35	ND	ND	89.50 %	0.58	94.10 %	0.68	ND	ND	N	N	N	-	Y	Low
Winje et al. 2008	72 %	0.43(0.37–0.49)	79%	0.51(0.45–0.57)	78 %	0.39(0.32–0.47)	ND	ND	ND	0.45(0.37–0.52)	ND	ND	ND	ND	ND	0.66(0.56–0.77)	ND	ND	Y	N	N	-	Y	Low
Diel et al. 2008	69.20 %	0.276	ND	ND	ND	ND	44.20%	0.119	ND	ND	ND	ND	90.70 %	0.616	ND	ND	ND	ND	Y	N	N	-	Y	low

2006, amended 2011

Table 6 Degree of concordance between Mantoux tests and IGT and corresponding threshold for Mantoux test

Evidence statements

Low quality evidence from four studies with 2646 participants showed that there was a higher level of concordance and agreement between IGT and Mantoux test when both tests were used in non-BCG-vaccinated populations than in populations who were BCG vaccinated.

Low quality evidence from three studies with 2351 participants showed that BCG vaccination decreased both concordance and agreement between the assay results of IGT and Mantoux tests.

Low quality evidence from one study showed IGTs were more likely to detect progression to active TB than Mantoux tests over a 2-year period. Positive predictive values were 14.6% and 2.3% respectively.

Low quality evidence from one study following up 339 immigrant contacts for a median of 1.83 years showed that IGT and Mantoux tests were similar in detecting progression to active TB. Positive predictive values were 3.1% and 3.8% for Mantoux test thresholds of 10 mm and 15 mm and 2.8% and 3.3% for QFT and T-SPOT. Negative predictive values for the Mantoux test thresholds of 10 mm and 15 mm, and QFT and TSPOT were 100%, 99.3%, 98% and 98.3% respectively.

Very low quality evidence from four studies with 1636 participants showed very low levels of concordance between the Mantoux and IGTs in BCG-vaccinated populations

Health economics – diagnosing latent TB in adults and children who are recent arrivals from high prevalence countries

The published reviews of test accuracy identified were Pai et al. (2008) and Diel et al. (2010). Both use active TB as a proxy for the calculation of sensitivities and specificities. Because there was no differentiation between IGTs, midpoints were used for the accuracy estimates.

The base-case analysis is shown in table 7. It used a prevalence of 30% for latent TB in the cohort group. These results demonstrate that Mantoux tests/IGT and IGT are associated with ICERs which are just under £30,000

per QALY. These estimates are within a range that means NICE requires further consideration of the various input parameters before a decision can be made.

Table 7 Cost-effectiveness results for new entrants from high prevalence countries

Strategy	Cost	Effect (QALY loss)	ICER per QALY gained compared with no test	Net monetary benefit (£20,000 per QALY)
Pai et al. 2008				
No test	£316	9.98686	-	-
Mantoux test/IGT	£403	9.99015	£26,641	−£22
IGT	£452	9.99156	£29,043	−£43
Mantoux test	£458	9.99107	Dominated	Dominated
Diel et al. 2010				
No test	£316	9.98686	-	-
Mantoux test/IGT	£387	9.98925	Extended dominance	Extended dominance
IGT	£451	9.98994	£29,211.57	−£43
Mantoux test	£442	9.99150	Extended dominance	Extended dominance

ICER = incremental cost-effectiveness ratio IGT = interferon gamma test. QALY = quality-adjusted life year.

A number of sensitivity analyses were run and are presented in appendix L. The prevalence of latent TB in this population and the transformation rate of latent TB to active TB are presented in tables 8 and 9 because the GDG considered them to be two of the key parameters in the model. The net monetary results at £20,000 per QALY are presented in table 8.

2006, amended 2011

Table 8 Net monetary benefits at £20,000 per QALY gained for different prevalence rates and test accuracy sources for screening people from high prevalence countries

Prevalence	Mantoux test/IGT	IGT	Mantoux test
Pai et al. 2008			
0.01	−34	−73	Dominated
0.05	−32	−69	Dominated
0.1	−30	−64	Dominated
0.15	−28	−58	Dominated
0.2	−26	−53	Dominated
0.25	−24	−48	Dominated
0.3	−22	−43	Dominated
Diel et al. 2010			
0.01	−34	−74	Dominated
0.05	−33	−69	Dominated
0.1	−31	−64	Dominated
0.15	−30	−60	Dominated
0.2	−27	−53	Dominated
0.25	Extended Dominated	−48	Extended Dominated
0.3	Extended Dominated	−43	Extended Dominated
IGT = interferon gamma test. QALY = quality-adjusted life year.			

Table 9 Net monetary benefits at £20,000 per QALY gained for different transformation rates and test accuracy sources for screening people from high prevalence countries

Latent TB to active TB	Mantoux test/IGT	IGT	Mantoux test
Pai et al 2008			
0.01	-60	-97	Dominated
0.05	-9	-24	Dominated
0.1	55	66	Dominated
0.15	119	157	Dominated
0.2	183	247	Dominated
0.25	247	338	Dominated
0.3	311	428	Dominated
Diel et al 2010			
0.01	Extended dominance	-97	Extended dominance
0.05	Extended dominance	-15	Extended dominance
0.1	Extended dominance	67	Extended dominance
0.15	Extended dominance	149	Extended dominance
0.2	Extended	231	Extended

	dominance		dominance
0.25	Extended dominance	334	Extended dominance
0.3	Extended dominance	416	Extended dominance
IGT = interferon gamma test. QALY = quality-adjusted life year. TB = tuberculosis.			

These results suggest that as the prevalence of TB and the conversion rate of TB increase the tests (Mantoux test/IGT and IGT alone) will be cost effective. IGT appears to be the optimum choice based on cost effectiveness. However, the results indicate that relatively small differences in either the prevalence or the transformation rate could result in Mantoux test/IGT being the optimum choice. In addition, the deterministic ICER per QALY gained for Mantoux test/IGT suggests it is a cost-effective option.

Evidence to recommendations

The issue of generalisability of the studies to the UK population was raised as well as how the results could be applied to a UK setting. It was agreed that the studies had similar settings and prevalence figures to the UK. The GDG noted that IGT was being used in certain UK practices. The evidence presented was of low quality but it showed how a previous BCG vaccination would confound the Mantoux test results and not affect the IGT results. The GDG felt that good quality evidence to predict active TB in the future was required.

Evidence to recommendations – health economics (people who have arrived from high-prevalence countries)

Health economic analysis indicated that none of the tests were associated with ICERs of below £20,000 per QALY gained. However the GDG considered that the mean rate of transformation from latent TB to active TB was an underestimate and that the true rate was closer to 16% over 15 years; evidence from Kik et al. (2010) suggested equivalent rates of close to 3% over 2 years. At estimates this high, IGT alone is the most cost-effective option, followed by the Mantoux test/IGT dual strategy. The threashold for screening was reduced from 500/100,000 to 40/100,000 as the GDG considered this to be cost effective and provided the greatest health benefits. The GDG considered that while IGT alone appeared to be the most cost-effective option,

the dual strategy should remain as an alternative because there was significant uncertainty in the point estimates, it was a less expensive strategy that would be more effective in low incidence areas and, in particular, there were still issues over the operation of the tests and intersubject variability.

5.1.5 Diagnosis of latent TB in children

Key clinical question

Which diagnostic strategy is most accurate in diagnosing latent TB infection in children?

Evidence review

Of the 11 studies included:

- four were conducted in Asia (Chun et al. 2008, Higuchi et al. 2007, Higuchi et al. 2009, Okada et al. 2008), three in Europe (Brock et al. 2004, Hansted et al. 2009, Winje et al. 2008b), two in North America (Lighter et al. 2009, Tsiouris et al. 2006) and two in Australasia (Connell et al. 2006, Connell et al. 2008)
- ages ranged from 0 to 19 years
- grading of exposure differed between studies (for example, sleeping proximity, duration of exposure, contact type).

The studies also looked at other factors such as BCG vaccination and country of birth.

Exposure was measured in several ways:

- duration of contact
  - hours/day
  - hours/week
- sleeping proximity
  - same or different house
  - same or different room
- type of contact
  - household/close
  - non-household
  - unknown
  - school
  - casual.

2006, amended 2011

The following measures of effect were used:

- concordance between tests
- agreement between tests measured by kappa value
- risk factors for positive test result
- odds ratios.

Risk of development of active TB

Meta analysis of the results of a positive test associated with graded exposure to active TB was performed from six studies (Brock et al. 2004; Chun et al. 2008; Hansted et al. 2009; Higuchi et al. 2009; Lighter et al. 2009; Okada et al. 2008).

There were two longitudinal studies (Higuchi et al. 2007; Higuchi et al. 2009) that followed up participants to investigate the development of active TB.

Five studies (Anon ; Brock et al. 2004; Chun et al. 2008; Connell et al. 2006; Okada et al. 2008) looked at the concordance between IGTs and Mantoux tests.

Evidence statements

Moderate quality evidence from six studies with 935 children aged 0–18 years showed that a positive IGT was more strongly associated with increasing TB exposure than a positive Mantoux test (ratio of odds ratio 2.86 [95% CI 1.56 to 5.23]).

Low quality evidence from two studies that followed up 281 children aged 8–16 years who had a negative IGT test found that none had developed active TB within 888.5 person–years. Each child had been followed up for an average of just over 3 years. All the children had tested positive with a Mantoux test but 99% were BCG vaccinated. The studies were from the same group in Japan.

Moderate quality evidence from two studies with 110 children found that there was a low-to-moderate level of concordance between IGTs and Mantoux tests but a high level of concordance between the two commercial IGTs.

Low quality evidence from five studies with 461 children aged 0–18 years showed a wide variation in concordance between IGTs and Mantoux tests (kappa values ranging from 0.19 to 0.866). These studies were conducted in very diverse populations with different rates of BCG vaccinations and wide age ranges.

Evidence to recommendations

Because of their underdeveloped immune system, children would be more likely to develop active and more serious disease if they had latent infection. This risk is greater in children aged under 5 years.This could lead to disability or death depending on the location of the infection. The GDG observed that the evidence presented that determined the negative predictive values of the tests was of very low quality. It also felt that the generalisability of those studies could be an issue especially with regard to the BCG vaccination program in Japan. It was agreed that most paediatricians would choose to treat a high-risk child if they had a positive Mantoux test and negative IGT because there was very limited evidence to suggest that a negative IGT could completely exclude infection. The difficulty of phlebotomy and obtaining enough blood in children was discussed, generally in those under five years of age and especially when they are under two years. Indeterminate IGT results occur more frequently in younger children. The GDG was of the view that IGTs perform less well in younger children. The group also agreed that careful consideration should be given to high-risk young children, especially those aged under 5 years because false-negative results could have substantial implications.

Table 10 Diagnosis of latent TB in children

Study	Results[1] (IGT versus Mantoux tests in children aged 0–18 years)	Limitations	Inconsistency	Indirectness	Imprecision	Other considerations	Quality	2006, amended 2011
Meta-analysis (six studies) (Brock et al. 65–9;Chun et al. 389–94;Hansted et al. 41;Okada et al. 1179–87;Higuchi et al. 352–57;Lighter et al. 30–37)	ROR ranged from 0.70 to 10.09. The overall ROR value was 2.86 (95% CI 1.56 to 5.23). A value greater than 1 in this case means that IGT was more strongly associated with TB exposure than Mantoux test.	Y	Y	N	-	N	Low	

[1] Outcomes were associations between graded exposure and positive test.

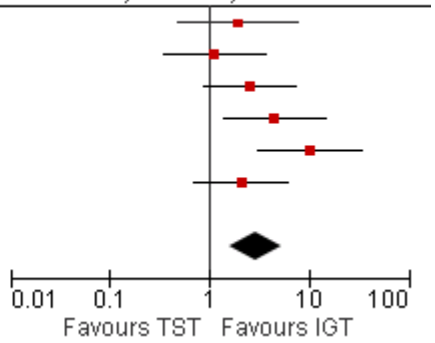
Limitation was the lack of a reference test meaning the measures of effect of sensitivity and specificity could not be determined. Inconsistency was the grading of exposure differed between studies (for example, sleeping proximity, duration of exposure, contact type). Imprecision was not measurable.

CI = confidence interval. IGT = interferon gamma test. ROR = ratio of odds ratios.

Figure 2 Forest plot of meta-analysis of IGT and Mantoux test results based on high-risk and low-risk exposure

Study or Subgroup	log[Odds Ratio]	SE	Experimental Total	Control Total	Weight	Odds Ratio IV, Random, 95% CI
Brock et al 2004(1434)	0.6576	0.7124	85	85	13.3%	1.93 [0.48, 7.80]
Chun et al 2008 (276)	0.1137	0.6096	71	71	16.3%	1.12 [0.34, 3.70]
Hansted et al 2009 (3427)	0.9398	0.5417	97	97	18.9%	2.56 [0.89, 7.40]
Higuchi et al 2009(164)	1.4986	0.6008	313	306	16.7%	4.48 [1.38, 14.53]
Lighter et al 2009 (282)	2.3114	0.6039	174	174	16.5%	10.09 [3.09, 32.95]
Okada et al 2008(393)	0.7371	0.556	195	195	18.3%	2.09 [0.70, 6.21]
Total (95% CI)			**935**	**928**	**100.0%**	**2.86 [1.56, 5.23]**

Heterogeneity: Tau² = 0.21; Chi² = 7.94, df = 5 (P = 0.16); I² = 37%
Test for overall effect: Z = 3.40 (P = 0.0007)



Both OR and ROR in this context, reflect test performance and provide an approach to evaluating tests in the absence of a reference test. OR is a function of test sensitivity and specificity and increases as one or both of these measures increase. Statistically OR = [sensitivity/(1-specificity)]/[(1-sensitivity)/specificity]

CI = confidence interval. IGT = interferon gamma test. OR = odds ratio. ROR = ratio of odds ratios. SE = standard error. See appendix L for definitions of high and low risk.

2006, amended 2011

Table 11Diagnosing latent TB in children (predicting development of active TB)

Study	Results[1] (IGT versus Mantoux test in children aged 8–16 years)	Limitations	Inconsistency	Indirectness	Imprecision	Other considerations	Quality
Two studies (Higuchi et al. 88–92;Higuchi et al. 352–7)	281 children with negative IGT but positive Mantoux test were followed up for a total of 888.5 person–years. None developed active TB. Mean duration of follow-up was 3 years. 99% of participants were BCG-vaccinated. Negative predictive value = 100%	Y	N	N	-	N	Moderate

[1] Outcome was prognostic value of IGT in predicting the subsequent development of potential active TB. Imprecision was not measurable. Limitations were defined as number of participants too few and follow-up too short for a precise result to be determined.

BCG = Bacille Calmette-Guerin. IGT = interferon gamma test; TB = tuberculosis.

2006, amended 2011

Table 12 Diagnosis of latent TB in children (agreement between tests)

Study	Results (IGT versus Mantoux test in childrenaged 0–18 years)	Limitations	Inconsistency	Indirectness	Imprecision	Other considerations	Quality
Five studies (Connell et al. 616–20;Connell et al. e2624;Brock et al. 65–9;Chun et al. 389–94;Okada et al. 1179–87)	Concordance between IGT and Mantoux tests as measured by kappa values ranged from 0.19 to 0.866	Y	Y	N	–	N	Low

Outcome was concordance between Mantoux test and IGT. Limitation was the lack of a reference test therefore sensitivity and specificity could not be determined. Inconsistency was that the grading of exposure differed between studies (for example, sleeping proximity, duration of exposure, contact type). Imprecision was not measurable.

IGT = interferon gamma test. TB = tuberculosis.

2006, amended 2011

5.1.6 Diagnosis of latent TB in people who have been in close contact with a person with active TB

Key clinical question

Which diagnostic strategy is most accurate in diagnosing latent TB in people who have been in close contact with a person with active TB?

Evidence review

Of the 27 papers selected:

- Mantoux test thresholds ranged from 5 mm to 30 mm
- 11 papers graded TB exposure, risk and proximal contact and it was possible to pool the results (Anon ; Alvarez-Leon et al. 2009; Brodie et al. 2008; Casas et al. 2009; Diel et al. 2008; Girardi et al. ; Kang et al. 2005; Kik et al. 2009; O'Neal et al. 2009; Topic et al. 2009; Zellweger et al. 2005)
- 16 papers (Adetifa et al. 2007; Alvarez-Leon et al. 2009; Arend et al. 2007; Brodie et al. 2008; Casas et al. 2009; Diel et al. 2009; Hesseling et al. 2009; Kang et al. 2005; Kik et al. 2009; Mirtskhulava et al. 2008; Pai et al. 2005; Porsa et al. 2007; Topic et al. 2009; Tripodi et al. 2009; Vinton et al. 2009; Zellweger et al. 2005) analysed the degree of concordance between Mantoux tests and IGT
- there were two longitudinal studies (Diel et al. 2008) which followed up participants to investigate the development of active TB.

2006, amended 2011

Table 13 Diagnosing latent TB in people who have been in close contact with a person with active TB.

Study	Results (IGT versus Mantoux test)	Limitations	Inconsistency	Indirectness	Imprecision	Other considerations	Quality
Meta analysis of 11 studies: Alvarez-Leon et al. (2009); Brodie et al. (2008); Casas et al. (2009); Diel et al. (2008); Girardi et al. (2009); Kang et al. (2005); Khanna et al. (2009); Kik et al. (2009); O'Neal et al. (2009); Topic et al. (2009); Zellweger et al. (2005).	Greater than 1 in this case means that positive IGT was more strongly associated with TB exposure than positive Mantoux test. The overall ROR value was 1.54 (1.08 to 2.19)	Y	Y	N	-	N	Low
Meta analysis of six studies: Brodie et al. (2008), Kang et al. (2005), Khanna et al. (2009), Kik et al. (2009), Topic et al. (2009), Zellweger et al. (2005).	The overall ROR value was 2.07 (1.23 to 3.48). Greater than 1 in this case means that positive IGT was more strongly associated with TB exposure than positive Mantoux test when BCG vaccination rate was greater than 50%.	Y	Y	N	-	N	Low
Meta analysis of five studies: Alvarez-Leon et al. (2009), Casas et al. (2009), Diel et al. (2008), Girardi et al. (2009), O'Neal et al. (2009)	The overall ROR value was 1.25 (0.94 to 1.67). Greater than 1 in this case means that positive IGT was more strongly associated with TB exposure than positive Mantoux test when BCG vaccination rate was less than 50%.	Y	Y	N	-	N	Low

Children were considered as a separate population. Outcome was diagnosis of latent TB in contacts from meta-analysis of ROR for IGT versus Mantoux test. Limitation was the lack of a reference test meant the measures of effect of sensitivity and specificity could not be determined. Inconsistency was that the grading of exposure differed between studies (for example, sleeping proximity, duration of exposure, contact type). Imprecision was not measurable.

BCG = Bacille Calmette-Guerin. IGT = interferon gamma test; ROR = ratio of odds ratios. TB = tuberculosis

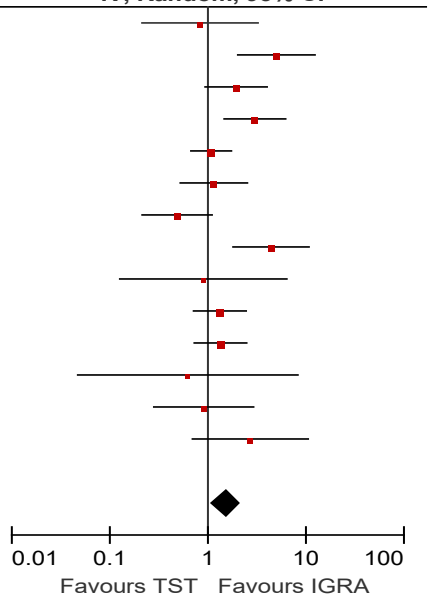
2006, amended 2011

Figure 3 Forest plot of meta-analysis of IGT and tuberculin skin test results based on high-risk and low-risk exposure to active TB

Study or Subgroup	log[Odds Ratio]	SE	Experimental Total	Control Total	Weight	Odds Ratio IV, Random, 95% CI
Alvarez-Leon etal2009(23)	-0.1839	0.6933	134	134	4.6%	0.83 [0.21, 3.24]
Brodie etal 2008 (479)	1.6094	0.4612	96	96	7.4%	5.00 [2.02, 12.35]
Casas et al 2009(3428)	0.663	0.3696	143	143	9.0%	1.94 [0.94, 4.00]
Casas et al 2009(3428)	1.1048	0.3666	0	0	9.0%	3.02 [1.47, 6.19]
Diel et al 2008 (455)	0.0768	0.2414	601	601	11.5%	1.08 [0.67, 1.73]
Girardi et al 2009(3408)	0.1402	0.4001	115	115	8.4%	1.15 [0.53, 2.52]
Girardi et al 2009(3408)	-0.7222	0.417	0	0	8.1%	0.49 [0.21, 1.10]
Kang et al 2005(1199)	1.4838	0.453	120	120	7.5%	4.41 [1.81, 10.72]
Khanna etal 2009(112)	-0.1076	0.9991	147	126	2.6%	0.90 [0.13, 6.36]
Kik et al 2009(60)	0.2819	0.3135	282	282	10.0%	1.33 [0.72, 2.45]
Kik et al 2009(60)	0.2965	0.3122	0	0	10.1%	1.35 [0.73, 2.48]
O'neal et al 2009 (137)	-0.471	1.3176	61	61	1.6%	0.62 [0.05, 8.26]
Topic et al 2009 (226)	-0.0976	0.5956	54	54	5.6%	0.91 [0.28, 2.91]
Zellweger et al2005(1101)	0.9963	0.6917	91	91	4.6%	2.71 [0.70, 10.51]
Total (95% CI)			**1844**	**1823**	**100.0%**	**1.54 [1.08, 2.19]**

Heterogeneity: Tau² = 0.22; Chi² = 29.36, df = 13 (P = 0.006); I² = 56%

Test for overall effect: Z = 2.40 (P = 0.02)



Both OR and ROR in this context, reflect test performance and provide an approach to evaluating tests in the absence of a reference test. OR is a function of test sensitivity and specificity and increases as one or both of these measures increase. Statistically OR= [sensitivity/ (1-specificity)]/ [(1-sensitivity)/specificity].

IGT = interferon gamma test. OR = odds ratio. ROR = ratio of odds ratios. TB = tuberculosis. See appendix L for definitions of high and low risk exposure.

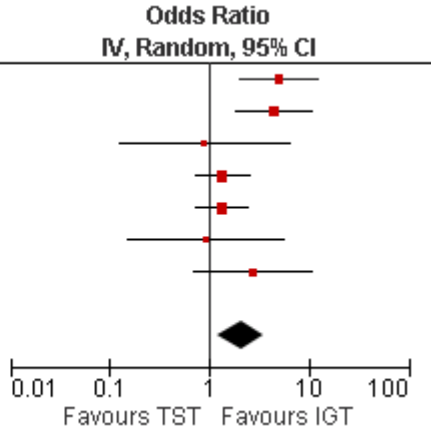
2006, amended 2011

Figure 4 Forest plot of meta-analysis of IGT and tuberculin skin test results based on high-risk and low-risk exposure to active TB stratified by BCG vaccination rates

>50% BCG-vaccinated

Study or Subgroup	log[Odds Ratio]	SE	Weight	Odds Ratio IV, Random, 95% CI
Brodie 2008(479)	1.6094	0.4618	16.3%	5.00 [2.02, 12.36]
Kang 2005 (1199)	1.4838	0.453	16.6%	4.41 [1.81, 10.72]
Khanna 2009 (112)	-0.1076	0.999	5.8%	0.90 [0.13, 6.36]
Kik 2009 (60)	0.2965	0.312	22.3%	1.35 [0.73, 2.48]
Kik 2009 (60)	0.2817	0.3134	22.2%	1.33 [0.72, 2.45]
Topic 2009 (226)	-0.0976	0.917	6.7%	0.91 [0.15, 5.47]
Zellweger 2005 (1101)	0.996	0.691	10.1%	2.71 [0.70, 10.49]
Total (95% CI)			**100.0%**	**2.07 [1.23, 3.48]**

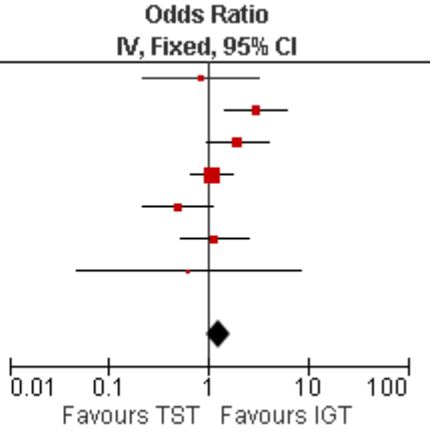
Heterogeneity: Tau² = 0.22; Chi² = 11.86, df = 6 (P = 0.07); I² = 49%
Test for overall effect: Z = 2.73 (P = 0.006)



<50% BCG-vaccinated

Study or Subgroup	log[Odds Ratio]	SE	Weight	Odds Ratio IV, Fixed, 95% CI
Alvarez-Leon 2009 (23)	-0.1839	0.6933	4.5%	0.83 [0.21, 3.24]
Casas 2009 (3428)	1.1048	0.3666	16.0%	3.02 [1.47, 6.19]
Casas 2009 (3428)	0.663	0.3696	15.7%	1.94 [0.94, 4.00]
Diel 2008 (455)	0.0768	0.2414	36.8%	1.08 [0.67, 1.73]
Girardi 2009 (3408)	-0.722	0.417	12.3%	0.49 [0.21, 1.10]
Girardi 2009 (3408)	0.1402	0.4	13.4%	1.15 [0.53, 2.52]
O'neal 2009(137)	-0.471	1.3175	1.2%	0.62 [0.05, 8.26]
Total (95% CI)			**100.0%**	**1.25 [0.94, 1.67]**

Heterogeneity: Chi² = 13.37, df = 6 (P = 0.04); I² = 55%
Test for overall effect: Z = 1.53 (P = 0.13)



2006, amended 2011

BCG = Bacille Calmette-Guerin. CI = confidence interval. IGT = interferon gamma test. IV = TB = tuberculosis. See appendix L for definitions of high and low risk exposure.

Table 14 Diagnosis of latent TB in people who have been in close contact with a person with active TB (concordance between results).

Study	Results (IGT versus Mantoux test)	Limitations	Inconsistency	Indirectness	Imprecision	Other considerations	Quality
Sixteen studies[1] (Kang et al. 2756–61;Mirtskhulava et al. 513–9;Tripodi et al. 30;Pai et al. 2746–55;Casas et al. e6686;Topic, Dodig, and Zoricic-Letoja 103–8;Vinton et al. 215–21;Alvarez-Leon et al. 876–83;Hesseling et al. 840–6;Adetifa et al. 122;Brodie et al. 869–74;Porsa, Cheng, and Graviss 714–9;Kik et al. 820–8;Zellweger et al. 1242–7;Arend et al. 618–27;Diel et al. 1010–8)	Overall agreement range was 46.6–94%. Kappa values were 0.11–0.85	Y	N	Y	–	N	Low

2006, amended 2011

Diel et al. (2008)[2]	None of the 25 patients who were IGT positive and started treatment had developed active TB. Six of 41 patients (14.6%) who were IGT positive but refused treatment later developed active TB. Five of 219 patients (2.3%) who were Mantoux test positive and were not treated later developed active TB. These patients were followed-up for 2 years	Y	N	N	-	N	Low
Kik et al. (2009)[2]	Positive predictive values were Mantoux test ≥ 10 mm = 3.1%; Mantoux test ≥ 15 mm = 3.8%; QFT = 2.8% ; T-SPOT = 3.3% Negative predictive values were Mantoux test ≥ 10 mm = 100%; Mantoux test ≥ 15 mm = 99.3%; QFT = 98%; T-SPOT = 98.3% These patients were followed-up for median of 1.83 years	Y	N	N	-	N	Low

Children were considered as a separate population.

[1] Outcomes were diagnosis of latent TB in contacts and degree of concordance between Mantoux test and IGT results.

[2] Outcomes were diagnosis of TB in children and the prognostic value of IGT in predicting the subsequent development of potential active TB.

Imprecision was not measurable. Limitations were too few participants and too short a follow-up

IGT = interferon gamma test. QFT = QuantiFERON-TB . TB = tuberculosis. TSPOT = T-SPOT.TB

2006, amended 2011

Evidence Statement

Low quality evidence from 11 studies with 1844 participants showed that positive IGTs were more strongly associated with increasing TB exposure than positive Mantoux tests (ROR = 1.54 [95% CI 1.08 to 2.19]). In those studies with less that 50% BCG-vaccinated patients the ratio of odds ratio was 1.25 (95% CI 0.94 to 1.67), whereas in those with over 50% BCG-vaccinated patients it was 2.07 (95% CI 1.23 to 3.48).

Low quality evidence from 16 studies showed that the degree of concordance between Mantoux test and IGT results, as measured by kappa values, was between 0.11 and 0.85.

Low quality evidence from one study showed IGTs were more likely to detect progression to active TB than Mantoux tests over a 2-year period. Positive predictive values were 14.6% and 2.3% respectively.

Low quality evidence from one study following up 339 immigrant contacts for a median of 1.83 years showed that IGTs and Mantoux tests were similar in detecting progression to active TB. Positive predictive values were 3.1% and 3.8% for Mantoux test thresholds of 10 mm and 15 mm and 2.8% and 3.3% for QFT and T-SPOT. Negative predictive values were 100%, 99.3%, 98% and 98.3% respectively.

Evidence to recommendations

The population of this group included healthcare workers who were in contact with people with active TB and non healthcare workers, who by way of residence, had been in close contact with a person with active TB. The GDG was presented with evidence showing the meta-analysis of ROR for comparing IGTs with Mantoux tests. This was stratified by percentage BCG vaccination. When adjusted for BCG vaccination, IGTs showed a better ROR than Mantoux tests. The GDG felt that although IGTs seemed better from ROR, the evidence was of poor quality and that recommendations should ideally be based on longitudinal studies that aimed to determine positive and negative predictive values of a person developing active TB.

Evidence to recommendations – health economics (contacts)

The health economic analysis for contacts was extrapolated to this population. This analysis indicated that there was uncertainty over which testing strategy was the optimal choice. Therefore, the GDG considered that both tests should be offered and that depending on operational issues, the most appropriate should be used.

5.1.7 Diagnosis of latent TB in people who are immunocompromised

Key clinical question

Which diagnostic strategy is most accurate in diagnosing latent TB in people who are immunocompromised?

Evidence review

Of the 16 papers selected:

- five papers (Balcells et al. 2008; Jones et al. 2007; Luetkemeyer et al. 2007; Mandalakas et al. 2008; Talati et al. 2009) looked at people with HIV. The paper by Mandalakas et al. (2008) also had a children's population.
- seven papers (Bartalesi et al. 2009; Cobanoglu et al. 2007; Matulis et al. 2008; Ponce de et al. 2008; Shovman et al. 2009; Soborg et al. 2009; Vassilopoulos et al. 2008) looked at participants who had rheumatoid arthritis, or rheumatic or inflammatory disease
- one study (Richeldi et al. 2009) combined people with HIV, who have had a liver transplant and who have haematological malignancy
- one paper (Manuel et al. 2007) looked at participants with chronic liver disease
- one paper (Piana et al. 2006) investigated patients in the haematology department who were immunosuppressed
- one (Schoepfer et al. 2008) looked at people with Crohn's disease and ulcerative colitis

Table 15 Diagnosis of latent TB in patients who are immunocompromised

Study	Results (discordance between Mantoux test and IGT in 973 people with HIV)	Limitation	Inconsistency	Indirectness	Imprecision	Other Considerations	Quality
Five studies (Balcells et al. 645–52;Luetkemeyer et al. 737–42;Talati et al. 15;Jones et al. 1190–5;Mandalakas et al. 417–23)	Overall discordance 0– 29.7%	Y	Y	N	–	Y	Low
	Mantoux test positive:IGT negative discordance 1.8–28.6%						
	Mantoux test negative:IGT positive discordance 0–29.7%						

Limitations: The lack of a reference test meant the crucial measures of effect of sensitivity and specificity could not be determined. Inconsistencies were noted in study designs: although all studies were observational, some were cross-sectional, and others were retrospective. Some studies were prognostic in design, others were diagnostic and some studies seemed to be a hybrid of both. Imprecision was not measurable. Other considerations were that measuring the diagnostic value of the tests in this population was difficult because the performance of the tests depended on the immunocompetence of the participants.

IGT = interferon gamma test TB = tuberculosis.

2006, amended 2011

Table 16 Diagnosis of latent TB in children who are immunocompromised

Study	Results (discordance between Mantoux test and IGT in 23 children with HIV and mean age 4.4 years (range 1.1–11.1 years)	Limitation	Inconsistency	Indirectness	Imprecision	Other Considerations	Quality
One study Mandalakas et al. 417–23	Overall discordance 0–39.1%	Y	N	N	–	Y	Low
	Mantoux test positive:IGT negative discordance 13–25%						
	Mantoux test negative:IGT positive discordance 0– 39.1%						

Limitations were that the lack of a reference test meant the crucial measures of effect of sensitivity and specificity could not be determined: Imprecision was not measurable. Other considerations were that measuring the diagnostic value of the tests in this population was difficult because the performance of the tests depends on the immunocompetence of the participants.

IGT = interferon gamma test. TB = tuberculosis.

2006, amended 2011

Table 17 Diagnosis of latent TB in people who are immunocompromised (indeterminate results)

Study	Results (indeterminate IGT results in people with HIV)	Limitation	Inconsistency	Indirectness	Imprecision	Other Considerations	Quality
Three studies Luetkemeyer et al. 737–42;Talati et al. 15;Jones et al. 1190–95	1.83–17.87%	Y	Y	N	–	Y	Low
	Odds ratio for indeterminate results adjusted for CD4 count: below 100 cells /mm³ 4.8 (95% CI 1.55 to 4.75), 34.81 (95% CI 7.98 to 151.89) below 200 cells/mm³ 3.6 (95% CI 1.9 to 6.8), 47.58 (95% CI 5.89 to 384.5)	Y	Y	N	-	Y	Low
Limitations were that the lack of a reference test meant the crucial measures of effect of sensitivity and specificity could not be determined. Inconsistencies were in study design: although all studies were observational, some were cross-sectional, and others were retrospective. Some studies were prognostic in design, others were diagnostic and some seemed to be a hybrid of both. Imprecision was not measurable. Other considerations were that measuring the diagnostic value of the tests in this population was difficult because the performance of the tests depends on the immunocompetence of the participants. CI = confidence interval. IGT = interferon gamma test. TB = tuberculosis.							

2006, amended 2011

Table 18 Diagnosis of latent TB in people with rheumatoid arthritis who are immunocompromised

Study	Results (discordance between IGT and Mantoux test in 1121 people)	Limitations	Inconsistency	Indirectness	Imprecision	Other Considerations	Quality
Seven studies in people with rheumatoid arthritis (Vassilopoulos et al. 1271–6;Ponce de et al. 776–81;Bartalesi et al. 586–93;Cobanoglu et al. 1177–82;Soborg et al. 1876–84; Matulis et al. 84–90;Shovman et al. 1427–32)	Overall discordance 12.2–44.3%	Y	Y	N	–	Y	Low
	Mantoux test positive:IGT negative discordance 5.9–47.5%						
	Mantoux test negative, IGT positive discordance 1.6–23.7%						

Limitations were that the lack of a reference test meant the crucial measures of effect of sensitivity and specificity could not be determined. Inconsistencies were in study design: although all studies were observational, some were cross-sectional, and others were retrospective. Some studies were prognostic in design, others were diagnostic and some seemed to be a hybrid of both. Imprecision was not measurable. Other considerations were that measuring the diagnostic value of the tests in this population was a challenge because the performance of the tests depends on the immunocompetence of the participants.

IGT = interferon gamma test. TB = tuberculosis.

2006, amended 2011

Table 19 Diagnosis of latent TB in people who are immunocompromised (association between risk factors and positive test)

Study	Results (people with rheumatoid arthritis)	Limitations	Inconsistency	Indirectness	Imprecision	Other considerations	Quality
Two studies Soborg et al. 1876–84;Matulis et al. 84–90	Corticosteroid treatment: OR with IGT 1.11 (95% CI 0.30 to 4.14); RR with IGT 0.5 (95% CI 0.1 to 1.6) No Corticosteroid treatment: OR with Mantoux test 0.74 (95% CI 0.32 to 1.72); RR with Mantoux test 0.4(95% CI 0.1 to1.0)	Y	Y	N	-	Y	Low
	Disease-modifying antirheumatic drug treatment: OR with IGT 2.34 (95% CI 0.52 to 10.6); RR with IGT 0.7 (95% CI 0.3 to 1.7) No disease-modifying antirheumatic drug treatment: OR with Mantoux test 0.75 (95% CI 0.32 to 1.77); RR with Mantoux test 1.3 (95% CI 0.7 to 2.3) RR Mantoux test = 1.5 (95% CI 0.7 to 2.9)						

Limitations were that the lack of a reference test meant the crucial measures of effect of sensitivity and specificity could not be determined. Inconsistencies were in study design: although all studies were observational, some were cross-sectional, and others were retrospective. Some studies were prognostic in design, others were diagnostic and some seemed to be a hybrid of both. Imprecision was not measurable. Other considerations were that measuring the diagnostic value of the tests in this population was a challenge because the performance of the tests depends on the immunocompetence of the participants.

CI = confidence interval. IGT = interferon gamma test. OR = odds ratio. RR = relative risk. TB = tuberculosis

2006, amended 2011

Table 20 Diagnosis of latent TB in people with haematological conditions who are immunocompromised

No of studies	Results (discordance between IGT and Mantoux test in 380 people with haematological conditions)	Limitations	Inconsistency	Indirectness	Imprecision	Other Considerations	Quality
3 studies (Piana et al. 31–4;Manuel et al. 2797–801; Richeldi 2009 et al. 198–204)	Overall discordance 9–32.2%	Y	Y	N	–	Y	Low
	Mantoux test positive:IGT negative discordance 2.6–8.5%						
	Mantoux test negative:IGT positive discordance 6.4–29.6%						

Limitations were that the lack of a reference test meant the measures of effect of sensitivity and specificity could not be determined. Inconsistencies were in study design: although all studies were observational, some were cross-sectional, and others were retrospective. Some studies were prognostic in design and others were diagnostic and some seemed to be a hybrid of both. Imprecision was not measurable. Other considerations were that measuring the diagnostic value of the tests in this population was a challenge since the performance of the tests depends on the immunocompetence of the participants.

IGT = interferon gamma test. TB = tuberculosis.

2006, amended 2011

Evidence Statement

Low quality evidence from five studies showed that the level of discordance between IGTs and Mantoux tests in 973 adults with HIV ranged from 0% to 29.7% for negative Mantoux tests/positive IGTs and 1.8% to 28.6% for positive Mantoux tests/negative IGTs.

Low quality evidence from one study showed that in 23 children with HIV (mean age of 4 years) the positive Mantoux tests/negative IGTs discordance ranged from 13% to 25% and negative Mantoux tests/positive IGTs discordance ranged from 0 to 39.1% similar overall discordance

Low quality evidence from three studies showed that the rate of indeterminate results from an IGT test in 837 people with HIV ranged from 1.83% to 17.87%. The rate of indeterminate results was significantly higher in those with a CD4 count below 200cells/mm^3.

Low quality evidence from seven studies showed that in 1121 individuals with rheumatoid arthritis, the overall discordance between IGTs and Mantoux tests was between 5.9% and 47.5% for positive Mantoux tests/negative IGTs, and 1.6% to 23.7% for negative Mantoux tests/positive IGTs.

Low quality evidence from two studies showed that the level of discordance in patients with diseases including, chronic liver disease, non-Hodgkin's lymphoma, multiple myeloma, acute myeloid leukaemia, and chronic myeloma was between 6.4% and 29.6% for negative Mantoux tests/positive IGTs, and 2.6% and 8.5% for positive Mantoux tests/negative IGTs.

Evidence to recommendations

The GDG pointed out that it was important to differentiate the groups of people who were immunocompromised. The group agreed that the degree and type of immunosuppression was also important. There was general agreement that the evidence was of low quality. There was a lot of discordance between the tests in the immunocompromised population, but in general IGTs may identify more truly positive latent TB infections than Mantoux tests but the value of such tests varies with the nature and the degree of immunosuppression. The group discussed the stratification of some

of the HIV studies by CD4 count and agreed on the basis of the evidence presented that a CD4 count below 200cells/mm^3 was significantly associated with an indeterminate result. The group also strongly felt that people with HIV who have a CD4 count of 500cells/mm^3 or more should be tested in the same way as people who are immunocompetent because the tests would perform in a similar way in these two groups of people. Evidence that looked at the effect specific anti-TNFalpha medications had on the diagnosis of latent TB was not identified.

Evidence to recommendations – Health economics (immunosuppresion)
No health economic modelling was conducted in this patient group. However the modelling for contacts and people from high prevalence countries indicated that high rates of transformation from latent TB to active TB and worse outcomes would all result in improved cost-effectiveness estimates for the testing strategies.

5.1.8 Screening for latent TB in healthcare workers

Key clinical question
What is the effectiveness of screening using IGT for healthcare workers?

Evidence review
Although studies that included healthcare workers had been analysed as part of the contact tracing question (section 5.1.6), the GDG advised that screening in healthcare workers should be specifically looked at. This was because the GDG felt that the scope was open to interpretation with regard to pre-employment screening in the NHS. It was difficult to identify studies that were screening for latent TB in healthcare workers. Good quality studies would have been those which compared participants who had been screened for latent TB and offered treatment as appropriate with those who had not and followed up to determine those who developed active TB. No such studies were identified.

Five studies were selected for critical appraisal. Of these:

- two (Alvarez-Leon et al. 2009; Harada et al. 2006) looked at existing employees

- two (Cummings et al. 2009; Hotta et al. 2007) looked at newly hired workers
- two (Harada et al. 2006; Hotta et al. 2007) had participants of whom most were BCG vaccinated
- three (Alvarez-Leon et al. 2009; Hotta et al. 2007; Zhao et al. 2009) determined concordance and discordance.

The evidence from these screening studies was of very low quality. Most of the issues had already been addressed and analysed in the contact tracing question. Table 21 summarises this evidence.

Table 21 Effectiveness of IGTs for screening healthcare workers

Study	BCG vaccination	Healthcare workers	Discordance Positive Mantoux test/negative IGT	Discordance Negative Mantoux test/positive IGT
Cummings et al.	93% did not report BCG vaccination	Newly hired	Not determined	Not determined
Harada et al.	95%	Existing employees	Not determined	Not determined
Zhao et al.	Not indicated	Not indicated	25%	0%
Hotta et al.	Most BCG vaccinated	Newly hired	56.5%	0%
Alvarez-Leon et al.	35.1%	Existing employees	4%	2%

BCG = Bacille Calmette-Guerin. IGT = interferon gamma test.

Evidence statements

Evidence from three low quality papers showed that there was more discordance between positive Mantoux tests/negative IGT results than negative Mantoux tests/positive IGT results in 381 healthcare workers. Negative Mantoux tests/positive IGTs discordance was very low (less than 2%). Some of the healthcare workers were newly employed. Coverage and timing of BCG vaccination was variable. In two other studies discordance figures were not quantified.

Evidence to Recommendations

The GDG agreed that the level of evidence for screening studies was low. It also considered that healthcare workers would fall into the category of people

from high prevalence countries or individuals who had had contact with a person with active TB. They made recommendations based on the evidence from those populations. For healthcare workers who were immunocompromised, the recommendations for the immunocompromised group applied.

Health economics – Contact tracing for healthcare workers (this section also relates to the diagnosis of latent TB in people who have been in close contact with a person with active TB)

The economic model used the same structure, costs and health-related quality of life values as those in the model for adults from high prevalence countries. However, the difference is in the estimates of the test accuracy and the prevalence of latent TB infection in this cohort. The test accuracy was based on Girardi et al. (2009) and Diel et al. (2010). The baseline prevalence used was 20%.

The model assumed the treatment regimen was the same as for people from high prevalence countries and that diagnosing and screening for latent TB was done in an outpatient setting.

The base case analysis for this population is shown in table 22.

2006, amended 2011

Table 22 Cost-effectiveness of testing strategies for contacts

Strategy	Cost (£)	Effect (QALY loss)	ICER compared with no test (£)	Net monetary benefit (£20,000 per QALY gained)
Girardi et al. (2009)				
No test	380	9.9393	-	-
Mantoux test/IGT	476	9.9473	12,037	£64
IGT	531	9.9483	16,833	£29
Mantoux test	604	9.9484	24,637	-£42
Diel et al. (2010)				
No test	380	9.9393	-	-
Mantoux test/IGT	445	9.9435	15,174	£21
IGT	515	9.9473	16,244	£25
Mantoux test	567	9.9447	Dominated	Dominated

ICER = incremental cost-effectiveness ratio. IGT = interferon gamma test. QALY = quality-adjusted life year.

These results indicate that Mantoux test/IGT and IGT alone are both cost-effective testing options and that depending on the test accuracies used either option could be the optimum choice.

Table 23 presents sensitivity analysis on the prevalence of latent TB in this conctacts population. The transformation rate did not appear to be a major variable in the model. Results are reported as net monetary benefits at the £20,000 per QALY gained threshold.

2006, amended 2011

Table 23 Net monetary benefits at £20,000 per QALY gained for different prevalence rates and test accuracy sources for contact tracing

Prevalence	Mantoux test/IGT	IGT	Mantoux test
Girardi et al. (2009)			
0.01	−36	−97	Dominated
0.05	−15	−71	Dominated
0.1	11	−37	Dominated
0.15	38	−4	−83
0.2	64	29	−42
0.25	90	62	−1
0.3	116	95	40
Diel et al. (2010)			
0.01	−31	−85	Dominated
0.05	−20	−61	Dominated
0.1	−7	−33	Dominated
0.15	7	−3	Dominated
0.2	21	25	Dominated
0.25	34	54	Dominated
0.3	48	83	Dominated

At £20,000 per QALY gained the prevalence has to be over 10% for testing to be cost effective. At a £30,000 per QALY gained threshold the lowest prevalence rate that testing remains cost effective at is 6%. In the contacts model, the transformation from latent to active TB was implemented by a relative risk (please see 2006 guideline appendix L for more details) the net monetary results at £20,000 per QALY gained are presented in table 24.

2006, amended 2011

Table 24 Net monetary benefits at £20,000 per QALYgained for different transformation rates and test accuracy sources for contact tracing

Latent TB to active TB	Mantoux test/IGT	IGT	Mantoux test
Girardi et al. (2009)			
0	18	−23	−96
1	29	−10	−82
2	41	3	−69
3	52	16	−56
4	64	29	−42
5	75	42	−29
6	87	55	−16
Diel et al. (2010)			
0	−3	−20	Dominated
1	3	−9	Dominated
2	9	2	Dominated
3	15	14	Dominated
4	21	25	Dominated
5	27	36	Dominated
6	32	48	Dominated

These results indicate that if the risk of latent TB becoming active is high then the cost-effectiveness results improve for all the options.

These results also indicate that IGT or Mantoux test/IGT could be the optimum choice but that it is highly dependent on the prevalence of latent TB in the population.

Evidence to recommendations – health economics (healthcare workers and screening)

Testing for healthcare workers who have come into contact with someone with active TB should follow the recommendations for all people who have been in contact with a person with active TB.

No specific health economic modelling was conducted for this population group. However, evidence from the high prevalence country and contacts analysis indicates that the testing strategies may be cost effective because the outcomes of a healthcare worker contracting TB might be more significant than a regular adult contact. Therefore, given the uncertainties in the model and difference in local circumstances both tests should be offered.

Summary evidence to recommendations

IGTs showed little evidence of being affected by prior BCG vaccination, and showed stronger correlation with exposure categories than the Mantoux tests. This was shown in high prevalence groups and in those who have been in contact with a person with active TB. The specificity of IGTs seemed better, and there was less potential for false-positive results. It was not possible to determine, for either Mantoux tests or IGTs, the rate of false-negative results. The GDG felt that some people with false-negative results would develop active TB and therefore reduce the cost effectiveness of vaccination and treatment of latent TB infection.

High quality prospective studies in people with latent TB (as diagnosed by positive IGTs) found at TB contact tracing and new entrant screening, have not yet been performed to find what proportion of such persons went on to develop clinical disease.

Economic modelling was undertaken with various strategies from no action to a two-step strategy with either Mantoux tests followed by interferon-gamma testing, or serial IGTs. Of these options, the model provided most support, on grounds of cost-effectiveness, for a two-step approach with an initial Mantoux test, followed by an interferon-gamma test to confirm positivity. The GDG members also supported this because of clinical utility and feasibility.

In the studies evaluated, IGT show a stronger correlation with exposure than Mantoux tests. Much of the discordance between a positive Mantoux test and a negative IGT can be accounted for by prior BCG vaccination. The GDG agreed that in the absence of good quality longitudinal studies the relative benefit of IGT over Mantoux test in determining the need for treatment of latent infection is not certain. However they made recommendations in populations where they considered IGT to be of clear benefit especially in cases where IGT would reduce the uncertain diagnosis of Mantoux tests.

No further evidence was reviewed for other groups such as Prisoners/prison staff and nursing homes. However, the GDG felt that the tests should perform as with any other adults.

5.1.9 Evidence statements

Test results and TB exposure

In a UK study{17} of healthy adults in a contact tracing clinic, IGT (ESAT-6 ELISPOT assay) results had a strong positive relationship with increasing intensity of contact exposure (OR 9.0 per unit increase in exposure, 95%CI 2.6 to 31.6, p=0.001), whereas Mantoux test results had a weaker relationship with exposure (OR 1.9, 95%CI 1.0 to 3.5, p=0.05). (**2**)

In a study{11} of students aged 11–15 years in the UK from the same school as an index case, the odds of a test result being positive for each increase across four stratified exposure groups increased by a factor of 2.78 (95%CI 2.22 to 3.48, p<0.0001) for the IGT (ESAT-6/CFP10 ELISPOT assay) and 2.33 (95%CI 1.88 to 2.88, p<0.0001) for the Mantoux test. The IGT correlated significantly better with increasing exposure across the four groups than the Mantoux test (p=0.03). The odds of a positive IGT result increased by a factor of 2.51 (95%CI 1.58 to 3.99, p<0.0001) with each week of direct exposure, which was significantly higher (p=0.007) than that for the Mantoux test (OR 1.30, 95%CI 1.10 to 1.54, p=0.002). (**2**)

In contacts of index cases in the Gambia,{13} with increasing *M. tuberculosis* exposure, the percentage of participants who were tuberculin positive and interferon gamma test (ESAT-6/CFP-10 ELISPOT assay) negative increased from 11% of those sleeping in a different house from the index case to 32% of those sleeping in the same room (p<0.001). (**3**)

In contacts of an index case on an Italian maternity unit,{19} the odds for a test result being positive for each increase across four stratified exposure groups (from no discernible contact to household contacts) increased by 1.93 (95%CI 1.11 to 3.35, p=0.020) for the IGT (ESAT-6/CFP-10 ELISPOT assay) but there was no significant correlation for the Mantoux test. (**3**)

In Korea where BCG vaccination is mandatory,{15} a study found that the odds of a positive test result per unit increase in exposure across four groups, increased by a factor of 5.31 (95%CI 3.62 to 7.79) for the IGT (QuantiFERON-TB Gold) and by a factor of 1.52 (95%CI 1.2 to 1.91) for the Mantoux test (p<0.001). (**2**)

Test results and BCG status

Healthy adults in a contact tracing clinic in the UK,{17} had IGT (ESAT-6 ELISPOT assay) results which were not correlated with BCG vaccination status whereas Mantoux test results were significantly more likely to be positive in BCG vaccinated contacts (OR 12.1, 95%CI 1.3 to 115.7, p=0.03). (**2**)

Students aged 11–15 years from the same school as an index case in the UK{11} had IGT (ESAT-6/CFP-10 ELISPOT assays) which showed no significant relation with BCG vaccination status, however, BCG vaccinated children were significantly more likely to have higher Heaf grades than unvaccinated children (p=0.002). (**2**)

In a UK study{16} of healthy household contacts and healthy unexposed controls, ESAT-6 peptide-specific interferon-gamma-secreting cells were detected in 85% of the healthy household contacts who were tuberculin positive. None of the healthy control subjects without a history of TB exposure, responded to this IGT even though all unexposed control subjects were BCG vaccinated. (**3**)

Mantoux test negative Australian born medical students (or those born in another low TB prevalence country),{14} with no prior BCG, and no known exposure to TB, were BCG vaccinated and then tested again at five months. ESAT-6 stimulated interferon-gamma levels (using ESAT-6 QuantiFERON) were very low or undetectable in all students both before and after BCG vaccination. Of these students, 46% had Mantoux test responses of 0 to 4 mm and 54% had responses of ≥5 mm. Thirteen percent had Mantoux test results of ≥10mm. Under current Australian guidelines, one student with a 16mm result was defined as having a Mantoux tes result suggestive of *M. tuberculosis* infection. (**3**)

High school contacts in a TB outbreak in Denmark{9} who had high exposure to an index case and were not BCG vaccinated, had agreement between Mantoux test and IGT (QuantiFERON-TB Gold) results of 93% (95%CI 86 to 100%). This was 95% (95%CI 88 to 102%) in the low exposure group and an overall agreement between the two tests of 94% (95%CI 89 to 99%) in all subjects tested. The kappa value was 0.866, indicating high agreement between the two tests. (**3**)

In an Italian study{19} of contacts of an index case on a maternity unit, IGT (ESAT-6/CFP-10 ELISPOT assay) results were independent of BCG vaccination status. (**3**)

IGTs were prescribed by hospital physicians for inpatients or outpatients in an Italian study with no influence from the study investigators.{12} After excluding indeterminate results, the agreement between IGT (QuantiFERON-TB Gold) and Mantoux test results was significantly lower among BCG-vaccinated individuals than in non-vaccinated individuals (41.5% *vs*. 80.3%, p<0.0001). (**3**)

In a study of healthcare workers conducted in India{18} (where non-tuberculous mycobacteria are highly prevalent), previous BCG vaccination was not associated with Mantoux test or IGT (QuantiFERON-TB Gold) positivity. (**3**)

Indeterminate test results

An Italian study{12} found that indeterminate IGT results (QuantiFERON-TB Gold) were significantly over-represented in patients with a negative Mantoux test (28.6% *vs*. 6.6% in tuberculin positive patients, p<0.001) and were more frequent in patients receiving immunosuppressive therapies than in those who were not receiving such treatments (OR 3.35, 95%CI 1.84 to 6.08, p<0.0001). Immunosuppressive therapy was defined as cancer chemotherapy, systemic steroids, or anti-tumour necrosis factor alfa agents at the time of testing. (**3**)

5.1.10 Health economics 2006

A decision model was used to compare the expected cost-effectiveness of four strategies of testing for latent infection in the context of a contact tracing programme in England and Wales. The strategies compared were:

- Mantoux test /IGT
- Mantoux test followed by IGT for patients with a positive Mantoux test
- no test (inform and advise only).

It was assumed that treatment followed current policy: with appropriate therapy for people diagnosed with active TB or testing positive for latent infection, and BCG when appropriate for others. The analysis did not compare different types of skin tests or different types of IGT.

The model is a decision tree, which does not account for the dynamics of disease transmission within the population. Instead, for simplicity, it was assumed that each primary case of active disease is associated with a fixed number of secondary

2006

cases. This is probably a reasonable assumption when comparing tests with similar sensitivity, since the absolute difference in false negatives, and hence in opportunities for transmission within the community, will be small. However, estimates of the relative cost effectiveness of contact tracing *per se* are less robust and should be treated with caution.

Various assumptions were made about the epidemiology and likely concordance with testing and treatment programmes. However, it should be noted that these factors will vary with the context of contact tracing. There is also considerable uncertainty over the relative accuracy of the Mantoux test and IGT, as well as over some of the other model parameters. Whenever possible input parameters and assumptions were based on empirical evidence, but some key parameters were estimated by the health economist and GDG.

Cost-effectiveness of testing strategies in contact tracing

The basecase economic analysis suggests that the two-stage strategy (Mantoux test /IGT) is within the range usually considered 'cost-effective', at around £26,000 per quality-adjusted life-year (QALY) gained. Compared with this, IGT is not cost-effective (over £150,000 per QALY gained). Mantoux test is both less effective and more expensive than all of the other options (it is 'dominated').

Variation in optimal strategy with context of contact tracing

The results of the economic analysis were highly dependent on the context of the contact tracing scheme – with a higher-risk cohort of contacts, the expected benefits of early diagnosis of active cases, treatment of latent infection, and vaccination will be greater. Below a prevalence of about 10% none of the testing strategies is cost-effective. At intermediate levels of prevalence (between about 10% and 40%), the two-stage Mantoux test /IGT strategy is cost effective. Above 40% IGT on its own is the most cost-effective option.

Table 25: Cost-effectiveness of diagnostic strategies

Prevalence of infection	Strategy	Cost (£)	Effect (QALYs lost)	ICER[7] (£ per QALY gained)
0	No test	£31	0.00409	–
	Mantoux test/IGT	£58	0.00394	£178,835

[7] ICER = incremental cost-effectiveness ratio

	IGT	£102	0.00394	(Dominated)
	Mantoux test	£139	0.00404	(Dominated)
10%	No test	£191	0.02533	–
	Mantoux test/IGT	£240	0.02323	£23,351
	IGT	£282	0.02290	£126,813
	Mantoux test	£314	0.02310	(Dominated)
20%	No test	£351	0.04658	–
	Mantoux test/IGT	£423	0.04252	£17,575
	IGT	£463	0.04185	£60,073
	Mantoux test	£489	0.04217	(Dominated)
30%	No test	£512	0.06782	–
	Mantoux test/IGT	£605	0.06182	£15,553
	IGT	£643	0.06081	£38,081
	Mantoux test	£664	0.06123	(Dominated)
40%	No test	£672	0.08907	–
	Mantoux test/IGT	£788	0.08111	£14,522
	IGT	£824	0.07976	£27,132
	Mantoux test	£838	0.08029	(Dominated)
50%	No test	£832	0.11031	–
	Mantoux test/IGT	£970	0.10040	£13,898
	IGT	£1,005	0.09872	£20,578
	Mantoux test	£1,013	0.09936	(Dominated)

Uncertainty over optimal testing strategy for contact tracing

The results of the economic analysis were subject to a high degree of uncertainty. The results were very sensitive to assumptions about the relative accuracy of the two types of test, the risk of current and future TB in the cohort, the level of transmission to the wider population, and also to the expected net benefit of avoiding each active case of TB.

5.1.11 From evidence to recommendations

IGTs showed little evidence of being affected by prior BCG vaccination, and showed stronger correlation with exposure categories than did Mantoux test. This was shown in low prevalence groups, in household contacts, and in outbreak situations. The specificity of IGTs seemed better, and there was less potential for false positive results. It is not possible to determine, for either a Mantoux test or IGT, the rate of false negative results. Some people with false negative results will go on to develop active TB and thus reduce the cost-effectiveness of vaccination and treatment of latent TB infection.

Prospective studies in people with latent TB (as judged by positive IGTs) found at TB contact tracing and new entrant screening, have not yet been performed to find what proportion of such persons went on to develop clinical disease.

Economic modelling was undertaken with various strategies from no action to a two-step strategy with either a Mantoux test followed by interferon-gamma testing, or serial IGTs. Of these options, the model provided most support, on grounds of cost-effectiveness, for a two-step approach with an initial Mantoux test, followed by an IGT to confirm positivity. The GDG members also supported this because of clinical utility and feasibility.

2006

RECOMMENDATIONS – Partial update 2011

These recommendations update and replace recommendation R1 from CG33.

Diagnosing latent TB

R1 Offer Mantoux testing in line with the Green Book[8] to diagnose latent TB in people who are:

- household contacts (aged 5 years and older) of all people with active TB
- non-household contacts (other close contacts for example, in workplaces and schools).

R2 Consider interferon-gamma testing for people whose Mantoux testing shows positive results, or in people for whom Mantoux testing may be less reliable, for example BCG vaccinated people.

R3 If Mantoux testing is inconclusive, refer the person to a TB specialist.

New entrants from high-incidence countries

R4 Offer a Mantoux test to children aged 5–15 years. If positive, follow with an interferon-gamma test.

New 2011

[8] In this guideline the 'Green Book' is the 2006 edition of 'Immunisation against infectious disease', published by the Department of Health(available from http://www.dh.gov.uk) The Green Book contains details of people who may have suppressed responses to tuberculin skin testing.

R5 Offer either an interferon-gamma test alone or a dual strategy in people aged 16–35 years. For people over 35 years, consider the individual risks and benefits of likely subsequent treatment, before offering testing. (Refer to other sections for other groups e.g. immunocompromised)

R6 Offer Mantoux testing as the initial diagnostic test for latent TB infection in children younger than 5 years who have recently arrived from a high-incidence country. If the initial test is positive (taking into account the BCG history):

- refer to a TB specialist to exclude active disease **and**
- consider treating latent TB.

Household contacts 2- 5 years

For children younger than 2 years see R83-85

R7 Offer Mantoux testing as the initial diagnostic test for latent TB infection in child household contacts between the ages of 2 and 5 years. If the initial test is positive taking into account the BCG history:

- refer to a TB specialist to exclude active disease **and**
- consider treating latent TB**.**

R8 If the initial Mantoux test is negative but the child is a contact of sputum-smear-positive disease, offer an interferon-gamma test after 6 weeks and repeat the Mantoux test to increase the sensitivity (to reduce false negative results).

Contacts – outbreak situation

R9 In an outbreak situation when large numbers of individuals may need to be screened, consider a single interferon-gamma test for people aged 5 years and older.

People who are immunocompromised

R10 If latent TB is suspected in children who are immunocompromised, refer to a TB specialist.

R11 For people with HIV and CD4 counts less than 200 cells/mm^3, offer an interferon-gamma test and a concurrent Mantoux test. If either test is positive:

- perform a clinical assessment to exclude active TB **and**
- consider treating latent TB infection.

New 2011

R12 For people with HIV and CD4 counts of 200–500 cells/mm^3, offer an interferon-gamma test alone or an interferon-gamma test with a concurrent Mantoux test. If either test is positive:

- perform a clinical assessment to exclude active TB and
- consider treating latent TB infection.

R13 For other people who are immunocompromised, offer an interferon-gamma test alone or an interferon-gamma test with a concurrent Mantoux test. If either test is positive:

- perform a clinical assessment to exclude active TB **and**
- consider treating latent TB.

Healthcare workers

R14 Offer a Mantoux test to new NHS employees who will be in contact with patients or clinical materials if the employees:

- are not new entrants from high-incidence countries **and**
- have not had BCG vaccination (for example, they are without scar, other documentation or reliable history)[9].

R15 If the Mantoux test is negative, refer to the Green Book for BCG immunisation guidance. If the Mantoux test is positive, offer an interferon-gamma test.

R16 Offer an interferon-gamma test to new NHS employees who have recently arrived from high-incidence countries or who have had contact with patients in settings where TB is highly prevalent.

R17 Healthcare workers who are immunocompromised should be screened in the same way as other people who are immunocompromised.

Hard to reach groups

R18 Offer people from hard to reach groups a single interferon-gamma test.

New 2011

[9] If there is reliable evidence of BCG vaccination, refer to the Green Book.

5.2 Diagnosing active tuberculosis

5.2.1 Clinical introduction

Signs and symptoms of respiratory TB

Primary respiratory tuberculosis is often asymptomatic, but the fact that infection has occurred is shown by the development of a positive tuberculin skin test or interferon-gamma blood test. A history of recent contact with a person with TB is the most important factor in making the diagnosis. Occasionally, tuberculin conversion is accompanied by erythema nodosum or phlyctenular conjunctivitis. Mediastinal nodal enlargement as part of the primary complex can sometimes press on or discharge into a bronchus causing collapse of the distal lung or bronchial narrowing leading to wheeze or obstruction with distal over-inflation.{22}

In children with primary TB, weight loss, or weight loss and cough, are symptoms associated with culture confirmed TB. However, about half of all children with primary TB will have no symptoms.

Post-primary tuberculosis may be asymptomatic in the early stages, but symptoms, which can be either constitutional or respiratory, soon develop. Malaise, weight loss, fever and night sweats are the common constitutional symptoms. Cough is the commonest respiratory symptom, which is initially dry and non-productive but may later become productive, with haemoptysis in a small minority of cases. Breathlessness is a late feature, usually only occurring when a substantial amount of lung is destroyed or there is a significant pleural effusion. Chest pain is relatively uncommon, but can be pleuritic if peripheral lesions are present, or of dull ill-localised nature.

A study in Sudan, grading sputum smear positivity with clinical features showed multiple chest symptoms were positively correlated with sputum smear positivity. Also, the longer the duration of symptoms, the more this correlated with sputum smear positivity.{23} A comparison of the 'classic' symptoms of tuberculosis in patients with and without tuberculosis{24} is summarised in Table 26.

Table 26: Classic symptoms of tuberculosis

Symptom	TB (n=47)	Non-TB (n=516)	Odds ratio (95% CI)
Cough	81%	77%	1.27 (0.58–2.69)

Fever	70	59	1.64 (0.85–3.15)
Weight loss	64	27	4.74 (2.53–8.86)[10]
Night sweats	55	27	3.29 (1/79–6.04)[10]
Dyspnoea	47	50	0.88 (0.48–1.60)
Chest pain	27	26	1.08 (0.55–2.11)

A multivariate analysis{25} showed that the following features were positively associated with culture proven tuberculosis:

- the presence of TB risk factors or symptoms (OR 7.9)
- a positive skin test for tuberculosis (OR 13.2)
- a high temperature (OR 2.8)
- upper lobe disease on a chest radiograph (OR 14.6)

and that the following were negatively correlated with tuberculosis:

- shortness of breath (OR 0.2)
- crackles on physical examination of chest (OR 0.29).

Signs and symptoms of non-respiratory TB

Tuberculosis can affect nearly every non-respiratory site, sometimes with a combination of respiratory and non-respiratory sites, or single or multiple non-respiratory sites.{22} As with respiratory tuberculosis, there can be systemic and site-specific symptoms. Weight loss is particularly associated with disseminated (including miliary) and gastrointestinal tuberculosis. Fever and night sweats are common in some non-respiratory sites of disease (disseminated, including miliary, and gastrointestinal TB), but are not common in others (peripheral lymph nodes, skin, bone and joint, genitourinary TB). Tuberculosis has to be considered in the differential diagnosis of an unexplained fever, particularly in those born abroad and/or in ethnic minority groups.

Because of the multiplicity of potential sites of non-respiratory TB, suggestive symptoms are considered site by site.

Signs and symptoms of lymph node TB

Nearly half of all non-respiratory TB in England and Wales occurs in peripheral lymph nodes, mainly cervical.{26},{27} The nodal enlargement in TB is usually

[10] significant difference

gradual and painless, but can be painful if rapid. The usual absence of erythema and warmth makes the classical 'cold abscess'. The nodes originally are discrete and firm, but may later mat together and become fluctuant as necrosis develops, which can discharge through the skin with sinus formation and superficial ulceration. Persistent lymphadenopathy of over four weeks duration in people other than white UK-born should be regarded as TB until proven otherwise and investigated appropriately.

Signs and symptoms of bone and joint TB

Bone and joint TB accounts for some 10–15% of non-respiratory disease, with approximately 50% in the spine, and 50% in a wide range of other bones and joints.{28},{29}

With spinal disease pain is the commonest symptom, and may be accompanied by local tenderness or slight kyphosis. Grosser kyphosis occurs when disease has progressed. Paraspinal abscesses can develop and may present as a loin mass, or as a psoas abscess pointing below the groin or causing psoas spasm with hip flexion. Compression on spinal nerve roots can mimic abdominal pathology. Extradural abscess or spinal collapse and subluxation can lead to sensory and motor symptoms involving the legs and sphincters due to spinal cord compression. Back pain and/or neurological signs should have an infective process in the differential diagnosis, particularly in ethnic minority groups.

A wide range of other joints can be involved. TB should be included in the differential diagnosis of unusual bone and joint lesions, particularly of an isolated lesion or a mono-arthritis in an ethnic minority group.

Signs and symptoms of gastrointestinal TB

This form of disease, as with nearly all other non-respiratory sites, is much commoner in ethnic minority groups. The gastrointestinal tract can be involved anywhere along its length, but peri-anal and upper gastrointestinal sites are uncommon (3% of gastrointestinal TB).{30} Series in both the developing{31} and developed world{32} show approximately one third of cases present acutely simulating abdominal emergencies and two thirds with a more gradual onset. Of the cases with an acute onset, approximately one half have right iliac fossa pain simulating acute appendicitis and the other half acute intestinal obstruction. Of

those with a more gradual onset of symptoms, fever and malaise, abdominal pain and weight loss are the commonest described symptoms,{32} being found in 72%, 60% and 58% of cases respectively in another series.{33} Abdominal distension, usually due to ascites, is reported in between 10%{32} and 65%{34} of cases. There may be right iliac fossa tenderness simulating appendicitis, or a right iliac fossa mass simulating appendix abscess or carcinoma. The ileocaecal area is the commonest site of disease. With bowel involvement there may be acute or sub-acute small bowel obstruction with vomiting and abdominal distension; there may also be palpable mass. The colon distal to the caecum is involved in up to 10% of cases{32} and is a cause of gastrointestinal bleeding.{35}

Signs and symptoms of genitourinary TB

Genitourinary TB is one of the commoner sites of non-respiratory TB in white UK-born people. For example, in 1993 it accounted for 17% of non-respiratory cases in the white UK-born ethnic group, compared with 4% in people of Indian (subcontinent) origin.{27} In white cases renal tract lesions predominate but female genital disease predominates in the Indian sub-continent ethnic group.{36}

Renal tuberculosis is often a 'silent' disease with insidious progression which can lead to total unilateral renal destruction. Systemic features such as weight loss, fever and night sweats are not common. As disease progresses, dysuria, haematuria, nocturia and pain either in the loin or anteriorly may occur. Renal disease can lead to ureteric and then bladder involvement by tubercle bacilli seeding distally. Bladder involvement initially leads to cystitis symptoms with frequency and dysuria, but as bladder wall inflammation with associated fibrosis worsens, bladder capacity falls and can be greatly reduced, the so-called 'thimble bladder' leading to marked frequency and nocturia due to a tiny bladder capacity. The urine with renal and ureteric disease, but particularly with bladder disease, shows proteinuria and haematuria on dipstick testing, and pus cells on microscopy but is sterile on standard culture. The finding of sterile pyuria should lead to the routine sending of three early morning urines for TB culture. A cold perinephric abscess can occur pointing in either the loin or like a psoas abscess in the groin. Prostatic, epididymal and testicular TB are less common. Testicular TB can present as a mass simulating testicular tumour.

Female genital TB is due to either haematogenous spread or direct spread from intra-abdominal disease. As with urological TB, systemic symptoms are uncommon unless there is associated abdominal tuberculosis. Infertility, either primary or secondary, is the commonest presentation of tubal and endometrial TB.{37} Most have no associated symptoms, but menorrhagia is reported in 20–25%, with much lower proportions having amenorrhoea or post menopausal bleeding.{37}

Signs and symptoms of disseminated (including miliary) TB

Disseminated TB occurs when tubercle bacilli are spread acutely though the blood stream. The symptoms are insidious at the onset with malaise, fever, anorexia and weight loss. In addition, headache from associated TB meningitis can occur with disseminated TB.

Signs and symptoms of central nervous system TB

Although only forming 5% of non-respiratory TB,{36} TB of the CNS is of disproportionate importance because of its significant morbidity and mortality. Early symptoms are non-specific with anorexia, malaise, headache, vomiting and altered behaviour. In children these can be poor feeding, irritability, altered behaviour, drowsiness or seizures. The prodromal phase can last from two weeks to two months, then focal neurological signs or decreasing level of consciousness occur. If cranial nerve palsies are present, 3rd and 6th nerve palsies are commoner than 7th and 8th nerve palsies. Internuclear ophthalmoplegia or lateral gaze palsies are less common but more serious because of midbrain or brainstem involvement.{37} Other neurological signs can develop depending on the site of endarteritis or infarction, including cerebellar signs, extrapyramidal movements such as choreoathetosis, hemiparesis or monoparesis.

Signs and symptoms of skin TB

Skin involvement can be due to disease of underlying structures, usually lymph node, bone or urogenital tract, with discharge through the skin, with sinus formation, so-called 'scrofuloderma'. Lupus vulgaris is a slowly destructive local skin form with dull red or violaceous edges. The tuberculides are forms of skin disease thought to be a manifestation of TB elsewhere in the body. Panniculitis, erythema induratum (Bazin's disease), and papular and papulo-necrotic forms are described and TB is in the differential diagnosis of such lesions, particularly in ethnic minority groups.{38}

Signs and symptoms of pericardial TB

TB can cause either pericardial effusion or constrictive pericarditis, particularly in ethnic minority groups. Fever, malaise, sweats, cough and weight loss can occur. The signs of pericardial effusion are oedema, pulsus paradoxus, a raised venous pressure, and hypotension with a narrow pulse pressure. With constrictive pericarditis, oedema, abdominal distension and breathlessness are the major signs and symptoms. A lymphocytic exudate on pericardial aspirate should be regarded as TB until proven otherwise.

Signs and symptoms of TB at other sites

TB should be considered in the differential diagnosis of adrenal deficiency, liver abscess, pancreatic mass in young adults with fever, and for isolated 'cold' abscesses wherever found, particularly in ethnic minority individuals.

Diagnosing active respiratory TB

The diagnosis of TB is suspected from a combination of context, symptoms, clinical signs and investigations. The diagnosis is rarely made from a single piece of evidence, and the sensitivity and specificity of individual tests may not reflect the strength of multiple tests or data. Most of the data on the utility of individual tests comes from studies in patients with proven tuberculosis by positive culture. Certain clinical settings are highly suggestive of tuberculosis in ethnic minority groups or recent TB contacts. These are: a pleural effusion which is a lymphocytic exudate, or isolated mediastinal lymphadenopathy, either supported by a positive skin tuberculin test (or IGT). These scenarios should be regarded as tuberculosis until proved otherwise and investigated accordingly.

A significant minority of respiratory TB cases however are not bacteriologically confirmed, but are treated on suspicion and regarded as probable cases because of response to specific anti-tuberculosis medication. The guideline aims to advise clinicians on which tests may help if cultures have been, or are subsequently shown to be, negative.

In children, who often have no culture confirmation, scoring systems have been developed to help diagnosis based on context, symptoms, X-ray appearances and other investigations. Some scoring systems are better validated than others.{39}

Diagnosing active non-respiratory TB

Most forms of non-respiratory tuberculosis have a lower bacterial load than for pulmonary disease, being so-called pauci-bacillary forms. A relatively very low proportion of cases have positive microscopy for acid-fast bacilli (AFB), and with the lower bacterial loads, even with rapid culture (see section 5.4) it takes longer to obtain positive cultures. With many of the non-respiratory sites, biopsy histology, or, in the case of lymph node disease, needle aspiration cytology, is available well before bacteriology. The finding of caseating granulomas, or granulomas with Langhan's giant cells on histology or cytology, is very highly suggestive of tuberculosis. A number of other conditions however can cause non-caseating granuloma formation. In the absence of caseation or Langhan's giant cells, additional tests such as a tuberculin skin test or IGT may be needed to assist in diagnosis. Obtaining a sample for culture is important as this confirms the diagnosis and provides the drug susceptibility profile of the organism. One caution is that in children aged under five, particularly if they are of white UK-born origin, granulomatous lymphadenitis is much more likely to be *M. avium* complex (MAC) than *M. tuberculosis*. To confirm this, samples are sent for culture, management for *M. avium* being completely different from *M. tuberculosis* in this context.{40}

The yield of histology/cytology depends on tissue sample size, which is much smaller with aspiration cytology than biopsy, and on the level of immune response which generates the histological appearances. In HIV-positive individuals the histological response depends on the level of immunosuppression. With levels of CD4 lymphocytes above 200/µl typical TB histology is the rule, but as the CD4 cell count falls, particularly below 100/µl, less and less granuloma formation occurs, and with profound immunosuppression there may be no cellular histological response at all. In these circumstances however there is an increased likelihood of AFB being seen microscopically. The differential diagnosis in such very immunosuppressed individuals is usually between *M. tuberculosis* and MAC infection. Polymerase chain reaction (PCR) techniques may help in distinguishing between these infections on AFB microscopy-positive samples (see section 5.3). A similar diagnostic problem can occur when patients with a very low CD4 count are started on highly active antiretroviral therapy (HAART). The rapid fall in HIV viral load and rise in CD4 count allows an immune response to be mounted to either of these organisms, which was

not previously possible. Enlargement of cervical and intra-abdominal lymph nodes in particular are described in this context, which is known as the immune reconstitution or IRIS syndrome.

In some cases of non-respiratory tuberculosis, the diagnosis of TB is not entertained in the differential diagnosis, and the doctor, usually a surgeon, does not send any material for culture, instead placing the entire sample in formalin. This then completely precludes any attempt at bacterial culture, although if AFB are seen histologically it still allows PCR-based techniques to be used (see section 5.3). The same histological and cytological criteria apply as in Table 27. Tuberculin skin tests or whole blood interferon-gamma based tests may be needed to assist with histological appearances that are not fully diagnostic.

5.2.2 Methodological introduction

Diagnosing active respiratory TB: testing while awaiting culture results

Studies were identified which calculated the sensitivity, specificity or predictive value of plain X-ray, sputum smear microscopy and gastric washings when compared with culture as the gold standard for the diagnosis of respiratory TB. Studies on sputum smear microscopy were excluded from review if they were conducted in non-Organisation for Economic Co-operation and Development countries as it was thought that in terms of background levels of mycobacteria and laboratory standards they might not be representative of the UK.

Eight studies examined the diagnostic accuracy of sputum smear microscopy in comparison with culture. Two US studies were excluded for methodological reasons.{41},{42}

Of the six remaining sputum microscopy studies, five were conducted in the US{43–47} and one in Turkey.{48} Three of these studies reported results for HIV-positive patients or those with AIDS.{43},{44},{47}

Four studies were identified which considered the diagnostic accuracy of chest X-ray in predicting culture results. One Danish study included all patients who had a respiratory sample examined for *M. tuberculosis* during a specified time period,{49}

2006

a South African study was of paediatric patients suspected of having TB{50} whilst two US studies{51},{52} considered diagnostic accuracy of chest X-ray in those with AIDS/HIV.

Three studies considered the diagnostic accuracy of gastric washings in children.{53–55} Two of the studies were performed more than ten years ago in developing countries in populations with a high proportion of malnourished children, thus their applicability to the UK today is highly questionable. A more recent study performed in Cape Town, South Africa{55} compared gastric lavage and induced sputum samples from children in terms of their diagnostic yield, reporting how many cases were culture positive, smear positive or both.

Methodological considerations include the following:

- In terms of sputum smear microscopy, serial testing of sputum samples will increase the sensitivity and specificity of the test.
- Sensitivity and specificity values are calculated in different ways, either on a patient basis or a specimen basis.
- Methods used for processing the sputum specimen (including the minimum volume of sputum required and whether the specimen is expectorated or induced) or the method of isolating cultures may differ in various settings.

Generally studies were unblinded (mostly because they were retrospective analyses). Blinding, however, is probably not crucial to avoid bias in the assessment of smear microscopy as the same samples are used for smear and culture and are subject to standardised laboratory procedures and definitions. It was notable that none of the studies identified were performed in the UK.

Diagnosing active respiratory TB if culture results are negative

Two studies{56},{57} addressed the issue of what other test results might support a positive diagnosis in those with a negative culture for TB but with suspected respiratory TB. In a South African study a group of black male goldmine employees with small lesions in the lung apices on chest X-ray, and a positive skin test but negative sputum culture, were followed up.{56} A diagnosis of TB was made if the smear became positive, if the culture yielded *M. tuberculosis* or if a histological diagnosis was made. A Hong Kong study had a subgroup of patients who had TB

diagnosed on the basis of chest X-ray but had negative culture results.{57} This group were followed up for future confirmation of TB by culture of *M. tuberculosis* from sputum, or by radiographic or clinical deterioration.

Methodological issues for consideration are that the gold standard against which diagnostic tests for TB are usually compared is microbiological identification of TB by culture. This is not a perfect gold standard and culture might be negative in TB cases due to 'pauci-bacillary disease' (only a small number of *M. tuberculosis* organisms are present), sampling error or technical problems. In these cases where culture is negative, the standard against which a diagnostic test might be compared could be response to treatment, clinical features or a positive culture in the future. A TB diagnosis in this population would probably be achieved on a case-by-case basis and this has thus not been the subject of many studies.

Diagnosing active non-respiratory TB: testing while awaiting culture results
Studies were searched for which considered the sensitivity and/or specificity of histology from biopsy when compared with culture as the gold standard for the diagnosis of non-respiratory TB. Biopsies could be obtained during surgical procedures or by fine needle aspiration.

Four studies were identified where sensitivity of histology was calculated or it was possible to calculate sensitivity from the results reported. These studies were performed in India,{58} Malawi,{59} the USA{60} and the UK.{61} Two studies reported results in HIV-positive patients.{59},{60}

Due to the recognition that non-respiratory TB can have low positive culture rates, studies often base a firm TB diagnosis on histology or culture. A positive histology result is thus not necessarily considered to be inaccurate in the presence of a negative culture. For this reason, there are few studies which consider the sensitivity of histology from biopsy compared to culture alone as the reference standard. Studies merely report the numbers positive on each test. This is not useful for calculating the sensitivity of histology as it is necessary to know the results for each patient on both tests.

These studies were not blinded, mostly because they were retrospective analyses. The majority of specimens used in these studies were lymph nodes and little

information is available concerning whether sensitivity and/or specificity may differ when using specimens from other sites.

Although the diagnostic accuracy of individual tests was considered in isolation, in reality test results would not be considered in isolation but would contribute to the overall evidence on which a diagnosis is made.

Diagnosing active non-respiratory TB if culture results are negative

Studies of patients with suspected non-respiratory TB where the results of histology from biopsy or tuberculin skin test were used to support a positive diagnosis in those with a negative culture for TB were searched for.

As with respiratory TB, culture is not a perfect gold standard and may be negative in TB cases for several reasons. In particular in non-respiratory TB, this may be due to pauci-bacillary disease.

No studies were identified in culture-negative populations where the results of histology from biopsy or tuberculin skin tests were used to support a positive diagnosis.

5.2.3 Evidence statements: diagnosing active respiratory TB while awaiting culture results

Sputum microscopy

In a comparison in the USA{45} of direct and concentrated specimens, results were analysed for the first three sputum specimens received from patients who were culture-positive for *M. tuberculosis* and from whom three or more specimens were received. The cumulative proportion of positive smears for each of the three smears for concentrated specimens were 74%, 83% and 91% and this was 57%, 76% and 81% for direct smears. (**2**)

Sensitivity of smears (all smears, not per patient) using more than or equal to 5 ml of sputum volume in a study in the USA{46} was 92%. This was significantly greater than a sensitivity of 72.5% in a previous period when all specimens were processed regardless of volume. In both periods the specificity of acid-fast smear for *M. tuberculosis* was comparable at 98%. (**2**)

The rates of smear positivity were calculated for specimens of expectorated sputum, induced sputum and bronchoalveolar lavage (BAL) specimens in a study in the USA.{43} Findings of smears of expectorated sputum specimens showed that 55% were culture positive for *M. tuberculosis* and were AFB smear positive. Smear positivity rates for induced sputum were 38% and for BAL were 26%. When the predictive value was calculated by including only the first smear-positive specimen from each patient the values were 87% for expectorated sputum, 70% for induced sputum and 71% for BAL. (**2**)

A Turkish study{48} compared Ziehl-Neelsen (ZN) and fluorescence microscopy (FM) staining of sputum smears. Where only one specimen was submitted the sensitivities of ZN and FM stains were found to be 61% and 83% respectively. When two were submitted the sensitivities were 66% and 83% and where three or more were submitted sensitivities were 80% and 92%. (**3**)

In a US study{43} of expectorated sputum specimens that were culture positive for TB, 55% of specimens from both patients with and without AIDS (mean 2.4 specimens per patient for both groups) were smear positive. (**3**)

In a group of non-HIV infected, culture-positive TB patients in the USA,{47} 57% had positive acid-fast smears compared with 60% of the HIV-infected patients with culture-positive TB (all had at least three specimens tested). Among the TB culture-positive HIV-infected patients, no significant differences were found in the frequency of positive acid-fast sputum smears between groups stratified by CD4 cell counts (in those with a CD4 count of <50, 58% had positive smears, with a CD4 count of 50–200, 60% had positive smears and with a count of >200, 56% had positive smears). (**3**)

In a USA study,{44} 70% of all HIV-infected culture-positive TB patients and 71% of all non-HIV infected culture-positive TB patients had at least one positive smear (up to three were performed). The sensitivity for the diagnosis of TB dropped to 55% and 64% respectively when only the first smear was considered. (**3**)

Chest X-ray

According to X-ray category in a Danish study,{49} positive predictive values and sensitivity for TB were 61% and 67% respectively with X-ray changes thought to be

due to TB. These values were 20% and 19% with X-ray changes compatible with TB; 14% and 9% with previous TB and radiographically active TB; 2% and 3% with previous TB but not radiographically active TB and 1% and 2% with X-ray changes thought to be due to other disease. None of the patients with normal chest X-rays were culture positive. (**1**)

In a South African study{50} of the diagnostic accuracy of X-ray in children, the results yield a sensitivity of 38.8% and a specificity of 74.4% compared to culture for the diagnosis of pulmonary TB using standard radiographs. (**3**)

In a group of culture-positive adult AIDS patients a US study{51} found 36% of patients had a primary *M. tuberculosis* pattern, 28% had a post-primary *M. tuberculosis* pattern, 14% had normal radiographs, 13% had atypical infiltrates, 5% had minimal radiographic changes and 3% had a miliary pattern. Normal chest radiographs were seen for 10 (21%) of 48 patients with less than 200 T-cells per microlitre and one (5%) of 20 patients with more than 200 T-cells per microlitre ($p<0.05$). (**2**)

In a US study{52} of TB culture-positive adults, 78% of HIV-negative patients' radiographs were consistent with post-primary pattern TB versus 26% of patients who were HIV positive ($p<0.001$). Only 11% of 18 significantly immunosuppressed HIV-positive patients (CD4 counts <200) had X-rays consistent with post-primary pattern TB, while all four patients with CD4 counts >200 had typical post-primary pattern chest radiographs ($p<0.005$). Of the 16 significantly immunosuppressed HIV positive patients the predominant chest X-ray finding was diffuse or multilobar infiltrates without an upper lobe predominance (N=8) followed by normal chest X-ray (N=3). (**3**)

Gastric washings

In a study of Haitian children{54} the sensitivity, specificity and predictive value of positive fluorescence microscopy of gastric washings compared with culture were 58%, 95% and 81% respectively from 536 specimens (median three specimens per patient). Among 49 children with at least one positive fluorescence microscopy of gastric washings, pulmonary TB was bacteriologically confirmed in 85%. Specimens were more frequently positive in far-advanced and miliary disease (82%) than in less severe disease (32%) ($p<0.001$). (**3**)

Culture was grown in 16 gastric washings samples in a study of Indian children{53} and smears for AFB were positive in only three samples, thus sensitivity was 3/16 or 19% (most children had only one sample taken). (**3**)

A South African study{55} of children with suspected TB found that sensitivity of gastric lavage compared with culture was 39%, specificity was 99%, positive predictive value was 88% and negative predictive value was 90% (based on three gastric lavage samples). Similar results were found for induced sputum specimens, however the yield of culture positive cases from each method was 88% from induced sputum and 66% from gastric lavage. (**2**)

5.2.4 Evidence statements: diagnosing active respiratory TB if culture results are negative

In South African black male goldmine employees with small lesions in the lung apices on chest X-ray and positive skin tests but negative sputum culture, TB was subsequently diagnosed in 88 (58%) of the 152 men. A diagnosis of TB was made if the smear became positive or the culture yielded *M. tuberculosis* or if a histological diagnosis was made. Active TB developed in these men from three to 58 months after entering the study, with a mean of 19.8 months.{56} (**2**)

A study performed in Hong Kong of patients with TB diagnosed on the basis of chest X-ray, but with negative culture results, obtained eventual confirmation of active disease requiring treatment in 99 (57%) of 173 patients. During the first 12 months 43% had a confirmed diagnosis. Confirmation of TB was by culture of *M. tuberculosis* from sputum, or by radiographic or clinical deterioration. There was bacteriological confirmation in 41%. (**3**)

5.2.5 Evidence statements: diagnosing active non-respiratory TB while awaiting culture results

In patients who presented with lymphadenopathy in one or more extra-inguinal sites in Malawi{59} and who did not respond to general antibiotics, it could be calculated that the sensitivity of histology compared to culture was 70%, the specificity was 59%, the positive predictive value was 52% and the negative predictive value was 67%. (**2**)

In a US study{60} of lymph node specimens where the cytology report was compared with culture results, the sensitivity of cytology was calculated to be 72%. (**2**)

The sensitivity of histology (using a variety of specimens although most frequently lymph nodes) compared with culture in an East London population was 97% with a positive predictive value of 69%.{61} (**2**)

Where culture was the gold standard, an Indian study,{58} calculated that in clinically suspected cases of tuberculous lymphadenitis, sensitivity, specificity and positive predictive values for cytology were 78.5%, 73% and 76.7% respectively. (**1**)

HIV-positive

In a study in Malawi{59} in HIV-negative patients with TB lymphadenitis (diagnosed on the basis of a positive culture or histology result), 100% had positive histology results and 83% had positive culture results. These figures were 78% and 56% for those who were HIV positive. Thus the HIV status of the TB lymphadenitis patients suggests a negative influence of HIV infection on the possibility of both histology and culture being indicative of TB (OR 0.10, 95%CI 0 to 1.17, p=0.06). (**2**)

In a US study{60} of lymph node specimens where the cytology report was compared with culture results the sensitivity of cytology in those who were HIV negative was 76% and it was 69% in those who were HIV positive. (**2**)

5.2.6 From evidence to recommendations

The Chief Medical Officer's TB Action Plan{2} calls for primary and community care staff to be aware of 'the signs and symptoms of the disease, local TB services and local arrangements for referring patients with suspected TB'. As this guideline is aimed at generalist clinicians as well as those working regularly with people with tuberculosis, recommendations include signs, symptoms and potentially helpful imaging techniques. NICE guidelines generally do not include service guidance (although exceptions have been made elsewhere in this guideline), and so recommendations for local referral are not given.

The GDG were aware of the General Medical Council's advice{62} on gaining consent for testing for 'serious communicable diseases', but noted that this advice

was reprinted from prior guidance specific to HIV and did not feel that routine clinical practice supported it in TB, and that it was at variance with the Public Health Act.{63}

Testing for active respiratory TB while awaiting culture results

The yield of positive sputum microscopy is improved by an adequate sputum sample (5 ml or more), concentration of sputum, analysing multiple samples, and by fluorescence microscopy as the screening tool. Smear positive rates are higher for spontaneously induced sputum than for either induced sputum or BAL samples. The positive predictive value of positive sputum microscopy is 92% for spontaneously produced sputum, and 71% for both BAL and induced sputum. There appeared to be little difference in the results between HIV-positive and HIV-negative patients in terms of bacteriological results and sputum smear positivity. Microscopy on gastric washings has some utility in children, but a recent comparative study in children showed a single induced sputum (by hypertonic saline) to be superior to three gastric washings. Gastric washings are less likely to provide useful material in adults, because of acidic inhibition. Chest X-ray changes are less specific in children and HIV-positive individuals, particularly if the CD4 count is under 200 cells/µl.

Testing for active respiratory TB if culture results are negative

The evidence does not assess the adequacy of the respiratory samples sent for culture; a negative culture result can reflect no growth at that time, while a positive result may be obtained later. Chest X-ray appearances consistent with TB were noted to show progression to culture-proven disease in over 50% of subjects in the studies analysed from South Africa and Hong Kong. The decision whether to start TB treatment will be a clinical one based on experience, context and appraisal of all the individual's results. Further culture samples are sometimes needed after treatment has begun, and will remain viable for a few days, though growth may be slower; the GDG agreed a threshold of one week in this regard.

IGTs may also have a role in ruling out infection with *M. tuberculosis*; this area is developing rapidly and may need to be updated ahead of the rest of the guideline in 2008.

Testing for active non-respiratory TB while awaiting culture results

Microscopy can be strongly suggestive of TB with certain patterns, and this is often confirmed by a positive culture if material has been sent. Although the data were entirely for peripheral lymph nodes, the GDG thought that this was likely also to apply to other non-respiratory sites.

The decision to biopsy should not be influenced by concerns about sinus formation, as there is no evidence to support this with modern chemotherapy.

Patient preferences are an important consideration in choosing biopsy or needle aspiration.

Posterior–anterior chest X-rays in people with suspected non-respiratory disease are helpful through detecting any coexisting respiratory disease, which will aid or confirm the diagnosis, and be another potential source of bacteriological confirmation. The GDG also agreed a range of other potential tests and imaging techniques.

Testing for active non-respiratory TB if culture results are negative

Although there was no evidence in this area, the GDG noted that continuous enhanced surveillance by the Health Protection Agency (HPA) shows that only some 55% of cases of TB are culture confirmed, and that this is often because no samples have been obtained, with the diagnosis being entirely histological. (However, other reasons include failures in the reporting system and limitations of the matching between Enhanced Tuberculosis Surveillance and MycobNet systems.) To raise the proportion of TB cases diagnosed, particularly at non-respiratory sites, more samples from common TB sites should be sent for TB bacteriology, which requires the education of those sending samples such as general, ENT and orthopaedic surgeons and radiologists performing biopsies.

IGTs may also have a role in ruling out infection with *M. tuberculosis*; this area is developing rapidly and may need to be updated ahead of the rest of the guideline in 2008.

5.2.7 RECOMMENDATIONS

R19 To diagnose active respiratory TB:

- a posterior–anterior chest X-ray should be taken; chest X-ray appearances suggestive of TB should lead to further diagnostic investigation C(DS)
- multiple sputum samples (at least three, with one early morning sample) should be sent for TB microscopy and culture for suspected respiratory TB before starting treatment if possible or, failing that, within seven days of starting C(DS)
- spontaneously produced sputum should be obtained if possible; otherwise induction of sputum or bronchoscopy and lavage should be used B(DS)
- in children unable to expectorate sputum, induction of sputum should be considered if it can be done safely, with gastric washings considered as third line B(DS)
- if there are clinical signs and symptoms consistent with a diagnosis of TB, treatment should be started without waiting for culture results (see section 6.1 for details) D(GPP)
- the standard recommended regimen should be continued in patients whose subsequent culture results are negative D(GPP)
- samples should be sent for TB culture from autopsy samples if respiratory TB is a possibility. D(GPP)

R20 To diagnose active non-respiratory TB:

- advantages and disadvantages of both biopsy and needle aspiration should be discussed with the patient, with the aim of obtaining adequate material for diagnosis B(DS)
- if non-respiratory TB is a possibility, part or all of any of the following samples should be placed in a dry pot (and not all placed in formalin) and sent for TB culture: D(GPP)
  - lymph node biopsy
  - pus aspirated from lymph nodes
  - pleural biopsy
  - any surgical sample sent for routine culture
  - any radiological sample sent for routine culture
  - histology sample
  - aspiration sample

2006

  - autopsy sample
- microbiology staff should routinely perform TB culture on the above samples (even if it is not requested) D(GPP)
- the appropriate treatment regimen should be started without waiting for culture results if the histology and clinical picture are consistent with a diagnosis of TB (see chapters 6 and 7) C(DS)
- all patients with non-respiratory TB should have a chest X-ray to exclude or confirm coexisting respiratory TB; in addition, tests as described in Table 27 should be considered D(GPP)
- the appropriate drug regimen (see chapters 6, 7 and 9) should be continued even if subsequent culture results are negative. D(GPP)

Table 27: Suggested site-specific investigations in the diagnosis and assessment of non-respiratory TB

Site	Imaging	Biopsy	Culture
Lymph node		• Node	• Node or aspirate
Bone/joint	• Plain X-ray and computed tomography (CT) • Magnetic resonance imaging (MRI)	• Site of disease	• Biopsy or para-spinal abscess • Site or joint fluid
Gastrointestinal	• Ultrasound • CT abdomen	• Omentum • Bowel	• Biopsy • Ascites
Genitourinary	• Intravenous urography • Ultrasound	• Site of disease	• Early morning urine • Site of disease • Endometrial curettings

2006

Disseminated	• High resolution CT thorax • Ultrasound abdomen	• Lung • Liver • Bone marrow	• Bronchial wash • Liver • Bone marrow • Blood
Central nervous system	• CT brain • MRI	• Tuberculoma	• Cerebrospinal fluid (CSF)
Skin		• Site of disease	• Site of disease
Pericardium	• Echocardiogram	• Pericardium	• Pericardial fluid
Cold/liver abscess	• Ultrasound	• Site of disease	• Site of disease

Cross-referring:

For details of rapid diagnostic tests, see sections 5.3 and 5.4.

For people with active TB, see treatment under chapters 6, 7 and 9.

For details of contact tracing, see section 12.2.

For details of notification and enhanced surveillance, see chapter 14.

5.3 Rapid diagnostic tests: molecular methods

5.3.1 Clinical introduction

Molecular probes for diagnosis

A number of methods have been developed which target and amplify specific regions of mycobacterial DNA, thus allowing a rapid result. However, such tests can result in false negative and false positive findings. Although rare, false positive results may occur due to contamination of the sample with environmental mycobacteria causing non-specific binding to the probe. More commonly, false negative results may occur due to low organism numbers or, in some sample types, for example CSF, to the presence of inhibitors. The specificity and sensitivity of the tests has been compared with culture proven disease. However, since 20–30% of

2006

pulmonary cases, and a higher proportion of non-pulmonary cases are not culture proven, the performance of molecular tests in these settings is difficult to assess.

Molecular probes for species confirmation

Species identification may sometimes be possible directly from the specimen using the techniques referred to above. Most usually, this will be possible only for *M. tuberculosis* complex organisms (*M. tuberculosis*, *M. bovis*, *M. africanum*). However, these methods may allow early differentiation between these organisms and environmental mycobacteria. These tests are most effective when applied to samples in which mycobacteria have been detected microscopically. Their use is currently recommended, to confirm true tuberculosis (ie transmissible disease) before a large contact tracing exercise, for example in a school or hospital, is carried out.{6}

When a sample yields a positive culture, rapid identification of several commonly encountered species may be possible. This may be done by the application of an expanded range of DNA amplification-based assays or by the use of non-amplified hybridisation probes. Both of these approaches are effective since the high numbers of organisms present in a positive culture overcome the problems associated with low bacterial counts and inhibition in the primary sample. The Mycobacterium Reference Service of the HPA now routinely confirms to clinicians whether a positive culture received is from the *M. tuberculosis* complex or not.

Molecular probes for rifampicin resistance

The incidence of multi-drug resistant strains of *M. tuberculosis* (MDR TB) in the UK is low (~1%) (see Appendix G). However, in some areas of the country and in some population groups the incidence is much higher. Whilst it should be noted that mono-resistance to rifampicin is found in approximately 5% of rifampicin-resistant strains, a high proportion of rifampicin resistance is associated with concurrent resistance to isoniazid (~95%). Thus the detection of resistance to rifampicin can be used as a marker for MDR TB with a high level of accuracy.

Rifampicin resistance is commonly due to one or more of several possible mutations of the *rpo*B gene and these can be detected using a PCR-based technique. A positive result from such a test should lead to the implementation of infection control measures and drug treatment for MDR TB until the results of

standard drug susceptibility tests are available. Risk factors for MDR TB, which should lead to such tests for rifampicin resistance, are listed in section 9.1. Clinicians should be aware that there is a small (<5%) false negative rate for these tests as a few mutations conferring rifampicin resistance are not at the *rpo*B gene tested for.{64},{65}

Molecular typing of M. tuberculosis isolates

In the past the typing of *M. tuberculosis* strains has been principally to detect previous events. This was largely due to the comparatively slow techniques available (for example, restriction fragment length polymorphisms). Newer methods based on the detection of variable numbers of tandem repeat sequences within the *M. tuberculosis* genome (variable number of tandem repeats (VNTR)/mycobacterial interspersed repetitive unit (MIRU) typing) are amenable to automation. As a result rapid, high-throughput typing systems have become available. These systems also have the advantage of digitised data which allow much easier computerised storage and analysis than previous typing methods. If this rapidity of method is used to type strains as they are isolated, then potential links between patients may be detected early enough to interrupt the disease transmission process. Thus an epidemiological tool may make an impact on diagnosis and transmission.

5.3.2 Methodological introduction

In consideration of the use of molecular methods for rapid diagnosis of TB, the review being developed by the NHS Heath Technology Assessment Programme{66} has been adopted. This aims to conduct a systematic review of the effectiveness of available diagnostic tests to identify mycobacteria. The review is not yet published.

The draft review of nucleic acid amplification tests (NAAT) found 163 studies which compared NAAT with a reference standard. There were 105 comparisons in respiratory specimens and 67 in non-respiratory specimens. In these studies 77 of the tests used were commercially produced (the amplified *Mycobacterium tuberculosis* direct (AMTD) test, the Amplicor, the Ligase Chain Reaction and Ampicis Myco B) and 86 were produced in-house (insertion element IS6110 or other targets).

Methodological issues concern the complexity of pooling data from diagnostic studies in particular due to variation in diagnostic thresholds. Furthermore, studies report pairs of related summary statistics (sensitivity and specificity) rather than a single statistic, requiring alternative statistical methods for pooling results. This review presents diagnostic odds ratios (DOR) in addition to sensitivity and specificity data. This is a single summary of diagnostic performance which although not easy to apply in clinical practice (it describes the ratio of the odds of a positive test result in a patient with disease compared to a patient without disease) is convenient to use when combining studies as it is often fairly constant regardless of diagnostic threshold. The DOR can be calculated from sensitivity and specificity data and where a test provides no diagnostic evidence the DOR is 1. It has been suggested{67} that a DOR of 25 or more in a test may provide convincing diagnostic evidence.

5.3.3 Evidence statements

The health technology appraisal (HTA) on rapid diagnostic tests{66} is not yet published. The GDG considered interim results, reporting the DOR statistic calculated by comparing NAAT *vs*. a reference standard. All evidence is graded at level 2.

5.3.4 From evidence to recommendations

Molecular probes for diagnosis

The HTA of rapid tests showed that their sensitivity was equivalent to culture in microscopy negative pulmonary samples, but there was an increased false negative rate in non-respiratory samples, particularly in pleural fluid and CSF. Significant false negative rates in these settings limit their utility, and could lead to failure to diagnose and treat TB.

Molecular probes for species confirmation

The GDG did not look into the HTA's interim results for molecular probes, but noted their role in rapid confirmation. They were not felt to be more reliable or useful than culture confirmation, and use was therefore limited to occasions when a rapid decision is needed on treatment or infection control measures. A further role was in preventing large scale contact tracing exercises from starting unnecessarily.

Molecular tests are less feasible on poorer samples, and the recommendations given below advise on their use on biopsy material.

Molecular probes for rifampicin resistance

Again, the GDG recognised the advantages of rapid results for drug resistance, but noted that MDR TB risk factors should be used to determine infection control measures at the earliest opportunity.

Molecular typing of M. tuberculosis isolates

Although this has not been subject to formal HTA appraisal, these methods have been considered by the HPA and a unified strategy using a 15 locus VNTR/MIRU system agreed. Such a strategy was recommended in the TB Action Plan.{2}

5.3.5 RECOMMENDATIONS

R21 Rapid diagnostic tests for *M. tuberculosis* complex *(M. tuberculosis, M. bovis, M. africanum)* on primary specimens should be used only if: D(GPP)

- rapid confirmation of a TB diagnosis in a sputum smear-positive person would alter their care, or
- before conducting a large contact-tracing initiative.

R22 Clinicians should still consider a diagnosis of non-respiratory TB if rapid diagnostic tests are negative, for example in pleural fluid, CSF and urine. B(DS)

R23 Clinical signs and other laboratory findings consistent with TB meningitis should lead to treatment (see section 7.1), even if a rapid diagnostic test is negative, because the potential consequences for the patient are severe. D(GPP)

R24 Before conducting a large contact-tracing initiative (for example, in a school or hospital), the species of *Mycobacterium* should be confirmed to be *M. tuberculosis* complex by rapid diagnostic tests on microscopy- or culture-positive material. Clinical judgement should be used if tests are inconclusive or delayed. D(GPP)

R25 If a risk assessment suggests a patient has MDR TB (see section 7.1): D(GPP)

- rapid diagnostic tests should be conducted for rifampicin resistance
- infection control measures and treatment for MDR TB should be started as described in chapter 9, pending the result of the tests.

R26 Rapid diagnostic tests for *M. tuberculosis* complex identification should be conducted on biopsy material only if: D(GPP)

- all the sample has been inappropriately placed in formalin, and
- AFB are visible on microscopy.

Cross-referring:

For details of managing drug-susceptible TB, see chapters 6 and 7.

For details of managing drug-resistant TB, see chapter 9.

5.4 Rapid diagnostic tests: automated liquid culture

5.4.1 Clinical introduction

Clinicians have been advised to obtain culture confirmation of tuberculosis whenever possible.{68} This not only confirms the diagnosis, but crucially also obtains material for drug susceptibility testing, which is important because of the current levels of drug resistance in England and Wales. The finding of isoniazid resistance (currently 6% of isolates) requires modification of treatment (see section 9.4), and that of MDR TB (currently about 1% of isolates) different infection control procedures (see section 9.3) and individualised treatment regimens based on the drug susceptibility data.

Until recently, culture for mycobacteria was done mainly on solid media, the Lowenstein-Jensen slope, or in broth media. These methods were slow, with cultures from microscopy positive material taking from 2–4 weeks, and for microscopy negative material 4–8 weeks. More recently rapid culture methods have been developed, with the potential advantages of more rapid growth and hence earlier drug susceptibility data, and also possibly increased sensitivity.

The national TB Action Plan has as one of its aims the use of rapid culture methods for diagnosis of all cases of tuberculosis.{2}

5.4.2 Methodological introduction

The reduced turnaround time of automated liquid culture in comparison with solid media is uncontested. In addition to time to detection of mycobacteria, study outcomes in comparisons between solid and liquid media also report increases

recovery rates for mycobacteria.{66} Sensitivity and or specificity cannot be reported in these studies as there is no reference standard.

There were no studies identified which directly addressed the issue of when (ie in what circumstances) automated liquid culture methods for the diagnosis of TB are most useful.

The HTA on rapid diagnostic techniques{66} is not yet published. The GDG considered interim findings on liquid culture techniques.

5.4.3 From evidence to recommendations

Given the evidence base and the self-evident speed of automated liquid culture, the GDG recommended their universal use.

Liquid culture methods require batches of samples to be processed. Their use becomes more costly per test if fewer samples are processed at any one time by a laboratory. The batching of samples sent to regional laboratories may not reflect future service organisation as this technology becomes more widely used over the lifetime of this guideline, but the recommendations allude to the effect of throughput on efficiency, quality control and cost-effectiveness. The NICE guideline, in the absence of clinical evidence, is unable to recommend service configurations to address this, though the GDG considered a 'hub and spoke' arrangement of regional laboratories.

5.4.4 RECOMMENDATIONS

R27 Clinical samples should ideally be sent for culture by automated liquid methods, bearing in mind that laboratories need a certain level of throughput to maintain quality control. D(GPP)

6 Management of respiratory tuberculosis

6.1 Drug treatment

6.1.1 Clinical introduction

Respiratory TB is defined as active TB affecting any of the following:

- lungs
- pleural cavity
- mediastinal lymph nodes
- larynx.

Duration of treatment

Six months of daily treatment with rifampicin and isoniazid, supplemented in the initial two months with pyrazinamide and either ethambutol or streptomycin (the six-month four-drug regimen) has been the evidence-based gold standard for TB treatment for at least the last 15 years. No new first-line drugs have been found for over 30 years. Attempts have been made to shorten the total duration of treatment by reducing the duration of the continuation phase of treatment. The comparators for such studies are the results of the six-month, short-course, four-drug regimen, which give a cure and completion rate of >95% and a relapse rate of 0–3% in both clinical trial{69} and routine clinic use.{70},{71} Such controlled studies have been largely conducted in adults not known to be HIV positive, with a few in HIV-positive individuals or in children.

Dosing schedule

Trials have also been conducted on reduced treatment frequency, comparing a daily dosing schedule with higher dosages of drugs given twice or thrice weekly. The aims of these studies were to reduce the total number of doses taken, as both an aid to adherence and treatment monitoring, and to reduce the costs of treatment in resource-poor countries. Intermittent treatment can be given either throughout the initial and continuation phases, or intermittently through the continuation phase after a daily intensive initial phase. Certain drug side effects (for example, 'flu-like syndrome', thrombocytopenia, shock and acute renal failure) are more common when rifampicin is given intermittently rather than daily, and are immunologically mediated. Twice- or thrice-weekly regimens lend themselves more readily to DOT as they require less frequent monitoring of medication, reducing the costs of supervision if done in a healthcare setting.

Combination medicines

Adherence with drug treatment is a major determinant of the outcome of treatment.{72} As an aid to adherence, combination tablets of three drugs (rifampicin, isoniazid and pyrazinamide) are available for use in the two-month initial

phase of treatment, and of two drugs (rifampicin and isoniazid) in the four-month continuation phase of treatment. The dosages in combination tablets however are those set for a daily dosing schedule. The other potential advantage of combination tablets is that they prevent accidental or inadvertent single drug therapy which can lead to acquired drug resistance within weeks in active TB disease. Care however is needed in the prescribing and dispensing of TB drugs in the UK, because of the similarities in names between several of the drugs (see Table 28).

Table 28 Commonly confused generic and brand names

Drug(s)	Brand name
Rifampicin (called rifampin in USA)	Rimactane, Rifadin
Rifabutin	Mycobutin
Rifampicin + isoniazid	Rifinah, Rimactazid
Rifampicin + isoniazid + pyrazinamide	Rifater
Isoniazid	Rimifon (not marketed in UK)
Ibuprofen	Rimafen

Enlarged hilar lymph nodes in children

Children with enlarged hilar lymph nodes that cause bronchial compression and collapse with respiratory distress frequently benefit from additional glucocorticoid therapy, although the evidence is limited.{73}

6.1.2 Current services

Dedicated TB clinics

In all parts of the country, over half of TB service providers taking part in our review of current services (see section 2.8) had a dedicated TB clinic. The percentage was 64% in London and 53% elsewhere in England and Wales. There may be a trend for these to be sited in services with a higher caseload of active TB (shown by number of notifications), but this is not reflected in caseload of screening (number of people screened). Screening is sometimes reported being carried out in a separate clinic, but it is not possible from our data to conclude whether or not there is consistency (or benefit) in having a combined approach.

This guideline recommends culturally relevant, practical and sensitive advice for patients, involving them in treatment decisions, and having a designated key worker they can contact. Bringing the TB service together in the framework of a dedicated clinic is one way to help the team achieve this. However, it is understandable that it will not be justified in all localities.

Nurse-led follow-up clinics

The review of current services found that outside London, 31% of TB service providers had nurse-led follow-up clinics. The majority of these conducted some follow up at the patient's home. In London, 55% of TB service providers had nurse-led follow-up clinics. None of these followed up patients at home. Variation in the provision of these nurse-led follow-up clinics did not seem to be explained by the caseload (notifications), staffing levels or presence of specialist personnel. It is impossible to conclude from our data whether the variation is appropriate to local epidemiology, geography or service models, but these are all factors that ought to have been considered in the design of the TB service.

Specialist TB+HIV clinics

The review of current services found that, outside London, only 5 of 60 (8%) participating service providers reported a specialist joint TB+HIV clinic, although in three cases this was a service by HIV physicians with TB nurse input. Five other clinics reported access to such specialist clinics elsewhere. In London, 10 of 33 (30%) service providers had a specialist TB+HIV clinic, although five other clinics reported access to these specialist clinics. Outside London, these specialist TB+HIV clinics tended to be sited in areas with higher numbers of notifications.

Specialist paediatric TB clinics

The review of current services revealed a few different models for providing paediatric TB care. Children were seen by respiratory or paediatric doctors with, in some cases, TB nurse input. In one clinic, generalist paediatric doctors ran a service for BCG, and treatment of active and latent TB with TB nurse input.

The number and proportion of service providers running clinics with specialist TB nurse input was 11 (17%) outside London, and 21 (64%) in London. Four other service providers, one outside London and three in London had access to these clinics. In two places outside London, the clinics were community paediatric clinics, and one was a hospital paediatric/BCG clinic. In 22 (34%) outside London, and three (9%) in London, patients were seen in paediatric clinics without TB nurse input. In 27 service providers outside London and six in London, patients were seen either by a respiratory physician, or the responsible healthcare professional was not recorded.

Access to specialist paediatric clinics seemed to predominate in areas of higher caseload outside London, but this distinction was less apparent within London. Variation in the provision of paediatric specialist services did not seem to be explained by staffing levels or the presence of specialist personnel. Given the special considerations required for diagnosing and treating TB in children, as well as providing advice to parents, it is important that adequate specialist expertise is available to the TB service. The above service models represent different ways of approaching this where caseload justifies a specific service model.

Outreach work

The review also looked into outreach in patients' homes and other community settings. This is reported in detail under section 8.3.

6.1.3 Methodological introduction

Duration of treatment

A Cochrane systematic review{74} assessed the effects of regimens lasting less than six months, compared to any longer regimens in the treatment of active TB (eg studies could compare two months *vs*. four months or five months *vs*. eight months). Seven trials were included (three trials in India,{75–77} two trials in Hong Kong,{78},{79} one trial in Singapore{80} and one in Germany{81}) and five of these studies compared regimens of less than six months with regimens of six months or more.

An additional RCT{82} was identified which compared a five-month regimen with a twelvemonth regimen. However, this was excluded due to methodological limitations.

No studies were found comparing treatment regimens of less than six months with longer durations in HIV-infected adults or in children.

A major consideration is that although these studies were very large (4,100 patients included in total), they did not perform intention to treat analyses and thus relapse rates are based only on study participants who complied fully with the treatment protocol (having taken at least 75–90% of scheduled treatment).

Dosing schedule

A Cochrane systematic review{83} compared the effectiveness of rifampicin-containing short-course treatment regimens, given twice or thrice weekly, with similar regimens given daily in adult patients with pulmonary TB. Only one RCT performed in Hong Kong was included within the review.{84} The review{83} was methodologically sound; however as it only included one study, this was reviewed separately. This RCT{84} was excluded due to limitations in its methodology.

The Cochrane review included studies where the intermittent arm was any rifampicin-containing multiple drug regimen with a maximum nine month duration, administered up to three times a week with an initial daily dosing phase which could not exceed one month (this was termed 'fully intermittent'). Three further RCTs{85–87} and a cohort study{88} were identified using similar inclusion criteria, except in terms of the initial daily dosing phase which was broadened to cover studies where this could be two months long, in line with the usual initial intensive treatment phase. Studies could also be intermittent during the intensive phase. The cohort study{88} and one RCT{87} were excluded due to methodological limitations.

In terms of HIV-infected populations and children, a US cohort study{89} in an HIV-infected population was identified but excluded on the basis of limitations in the methodology, as was an RCT which compared twice-weekly and daily chemotherapy in children with respiratory TB.{90} No further studies were identified in either of these populations.

None of the studies identified were blinded. Certainly this may have been problematic to achieve in terms of study participants, however those assessing outcomes could potentially have been blinded to treatment allocations.

Very few studies have compared intermittent regimens with daily regimens. Where studies have been conducted, apart from issues of methodology, there are a number of other variables which should be considered when attempting to compare studies and ascertain whether intermittent and daily regimens have equivalent effectiveness. These include whether the intermittent treatment was received during the intensive or continuation treatment phases or during both, the drugs and dosing regimens used, whether treatment was directly observed or self-administered and the frequency of the intermittent regimen (ie whether once, twice or thrice weekly).

There is little high-quality evidence in this area and none of the studies identified were performed in the UK. In particular, no robust evidence is available in HIV-positive individuals or children.

Combination medicines

Six RCTs compared fixed dose combination tablets with single-drug formulation regimens.{91–96} All of the studies except one used a fixed dose combination tablet containing isoniazid, rifampicin and pyrazinamide. The exception was an Indonesian study{96} which compared a four-drug, fixed-dose regimen containing isoniazid, rifampicin, pyrazinamide and ethambutol with single-drug formulations.

Four of the studies were excluded due to methodological limitations.{91},{92},{94},{95}

Two studies were included, one preliminary study from Indonesia{96} and one study from China,{93} which followed patients up for two years to assess relapse. In both of these studies treatment was directly observed in all patients, which is not a standard service model in the UK.

6.1.4 Evidence statements

Duration of treatment

A Cochrane systematic review{74} of seven RCTs compared regimens of six months or less with any longer regimens (thus not necessarily six months or longer). For those with active TB, relapse rates were significantly better in the longer groups of the meta-analyses of two months (OR 6.1, 95%CI 2.19 to 17.01), three months (OR 3.67, 95%CI 2.42 to 5.58) and four months (OR 3.64, 95%CI 1.71 to 7.75) of treatment *vs*. longer treatment, but not in the single trial of five *vs*. seven months. Relapse rates after longer (comparison) regimens ranged from 0–7% at one year (or more) and in the shorter treatment arms they ranged from 2–20% (the two highest rates of 18% and 20% being in the three-month regimen). (**1+**)

When only regimens of less than six months were compared with durations of six months or longer, relapse rates were significantly lower in the regimens of six months or more, for three months *vs*. six months (OR 15.61, 95%CI 4.97 to 49.04), three months *vs*. 12 months (OR 5.11, 95%CI 1.37 to 19.08), and four months *vs*.

2006

six months (OR 3.64, 95%CI 1.71 to 7.75) but not in the five *vs*. seven months comparison.{74} (**1+**)

There was little or no difference in the rates of adverse reactions or toxicity requiring a change or discontinuation of treatment when comparing regimens of six months or less with longer regimens and few or no deaths were reported in individual trials. Furthermore, the 'sterilising efficacy' (sputum culture negative immediately after the completion of treatment) varied little among treatments, providing no predictive value for relapse rates.{74} (**1+**)

Dosing schedule

In a RCT performed in Africa and Asia,{86} a significantly higher proportion of patients assigned a directly observed daily regimen in the two-month intensive phase rather than a directly observed three times weekly regimen, were culture negative at two months (85% *vs*. 77%, p=0.001). (**1++**)

In a Brazilian RCT{85} there was no significant difference between self-administered six-month treatment regimens, where treatment was daily for the first two months and then either daily or twice weekly during the continuation phase, in terms of the number of bacterial failures or deaths during treatment. (**1+**)

The same study{85} also found no significant difference between daily and twice-weekly regimens in the continuation phase of treatment in terms of adherence (measured by pill counts), relapse rates at 12 months follow up or adverse events. (**1+**)

Combination medicines

An Indonesian study{96} compared a four-drug, fixed-dose combination (isoniazid, rifampin, pyrazinamide and ethambutol) with the same drugs in separate formulations and found there was no significant difference in terms of sputum conversion at two months or cure, failure or defaulter rates. The difference in frequency of complaints during the intensive phase between the separate and combined drugs groups was significant in terms of gastrointestinal complaints (56% *vs*. 41% respectively, p<0.01) and muscle joint complaints (46% *vs*. 32% respectively, p=0.01). (**1+**)

In a comparison in China{93} of a six-month, three-drug, fixed-dose combination tablets (isoniazid, rifampin, pyrazinamide) regimen with the same drugs in separate formulations, at the end of two and six months of treatment, the bacteriological status of patients did not differ significantly in the two treatment groups as determined by examination of both sputum smear and culture. Bacterial relapse in those who completed treatment at two years was not significantly different between the two groups. 11.8% of patients in the combined drug group, and 15.5% of patients in the separate drugs group, experienced adverse reactions, most of which were insignificant and temporary. Patients in the combined drug group actually took 99.9% of their treatment doses whilst in the separate drug group, 97% of doses were taken. (**1+**)

6.1.5 From evidence to recommendations

Specialised clinical staff are central to good management of TB, as has been shown in audit results.{97},{98}

The Cochrane review of this area includes trials in adults not known to be HIV positive. Few data are available in either HIV-positive adults or in children, but the Cochrane review's conclusions should be applicable.

The increasing rates of isoniazid resistance seen in the epidemiology of England and Wales (see Appendix G) led the GDG to recommend a standard six-month, four-drug initial treatment regimen. Two studies have looked into the effect of this regimen in clinical settings in the UK and shown it to be effective and safe across susceptible and isoniazid-resistant strains.{99}

No studies compared twice- or thrice-weekly treatment with daily treatment throughout a six-month regimen, but nevertheless the GDG agreed that twice- and thrice-weekly regimens, with appropriate dosage adjustments, are effective in the treatment of tuberculosis. A single-arm, twice weekly regimen, using rifabutin in HIV-positive individuals with active tuberculosis in the USA (CDC TB Trials Consortium Trial Number 23), was stopped because of the development of acquired rifamycin resistance.{100} In addition to this concern, the twice-weekly regimen is the absolute minimum dosage strategy, and the penalty of missed doses may be

increased relapse or treatment failure. For this reason the thrice-weekly regimen, which has a greater safety margin for a few missed doses, is recommended.

Whilst being easier to supervise twice- or thrice-weekly treatment, the large number of different pills (necessarily given as separate formulations), particularly in the initial four-drug phase, can cause nausea and adversely affect adherence. Vomiting as a side effect of rifampicin can be reduced at dosages of 600 mg or more by being taken after breakfast. Flu-like syndromes are more common with intermittent as opposed to daily rifampicin treatment.

The dosages of combination tablets are set for once-daily treatment.

The cost to the patient of prescription charges is lower for combination tablets.

Few studies in the evidence base for combination medicines are free from methodological limitations. Only one study used the three-drug combination available in the UK.{93} Virtually all the data are from adult patients not known to be HIV positive, but the GDG felt that the conclusions can be extrapolated to children and HIV-positive individuals.

Given the benefits of combination tablets, and the key aim of treatment completion and adherence, the GDG recommended them.

6.1.6 RECOMMENDATIONS

R28 Once a diagnosis of active TB is made, the clinician responsible for care should refer the person with TB to a physician with training in, and experience of, the specialised care of people with TB. The TB service should include specialised nurses and health visitors. TB in children should be managed either by a paediatrician with experience and training in the treatment of TB, or by a general paediatrician with advice from a specialised physician. If these arrangements are not possible, advice should be sought from more specialised colleagues throughout the treatment period. C

R29 A six-month, four-drug initial regimen (six months of isoniazid and rifampicin supplemented in the first two months with pyrazinamide and ethambutol) should be used to treat active respiratory TB in:

- adults not known to be HIV positive. A
- adults who are HIV positive. B
- children. B

This regimen is referred to as 'standard recommended regimen' in this guideline.

R30 Fixed-dose combination tablets should be used as part of any TB treatment regimen. C

R31 A thrice-weekly dosing regimen should be considered for patients receiving DOT (see section 8.2). D(GPP)

R32 A twice-weekly dosing regimen should not be used for the treatment of active TB. D(GPP)

Cross-referring:
For details of DOT, see section 8.2.
For details of approaches to improve adherence, see section 8.3.
For details of managing drug-resistant TB, see chapter 9

6.2 Infection control

6.2.1 Clinical introduction

It has long been recognised that people who are sputum microscopy positive from spontaneously expectorated sputum are those cases with the highest infectivity, and pose a risk to household and other close contacts such as workplace contacts. For these reasons, traditionally, patients with pulmonary disease in whom tuberculosis is suspected are isolated in a single room. This isolation has been recommended until three separate sputum tests have been analysed. If these sputum tests are negative, the patient is usually deemed to pose a significantly lower infection risk. They may then be moved from the single room to a shared ward, provided there are no HIV-positive or other patients with major immunocompromise on the same ward. If patients are sputum microscopy positive, having so-called 'open' tuberculosis, and need to be admitted to hospital, isolation is required until treatment makes the person non-infectious.{101},{102} Such drug

treatment causes an extremely rapid fall in viable organisms in the sputum, even if AFB are still visible on microscopy.

Current clinical practice has been based on the 2000 BTS Joint Tuberculosis Committee guidance, which supported nursing adults with non-pulmonary tuberculosis on a general ward. However, aerosol-generating procedures such as abscess or wound irrigation are carried out in separate facilities.

6.2.2 6.2.2 Methodological introduction

Studies were searched for that focussed on measures directed at patients with infectious TB to prevent transmission to other patients or contacts. It was expected that these measures might include mask wearing by the patient, isolation in a single room, negative pressure rooms, germicidal ultraviolet radiation or air disinfectant at sites of transmission.

There were few studies which considered TB transmission to other patients or contacts rather than healthcare workers when assessing the effectiveness of infection control measures. This is likely to be due to healthcare workers having regular Mantoux tests tests available for analysis, the fact that healthcare workers are easier to follow up than patients and because employers must consider TB as an occupational hazard. Furthermore, studies tended to look at infection control in MDR TB rather than drug-susceptible TB patients. This seems to be because infection control measures were implemented in several hospitals in the USA after MDR TB outbreaks in the late 1980s and early 1990s.

Additional considerations are that the quality of the infection control measures, for example the level of negative pressure in a negative pressure isolation room, may vary over time.

Furthermore, infection control measures are often implemented together, which makes it difficult to assess the contribution of each measure.

One US study{103} without a comparison group that considered hospital transmission of TB among patients after the implementation of infection control measures was identified. This was excluded on the basis of methodological limitations.

No further studies were found that assessed the effects of infection control on patient TB transmission rates in either HIV-positive or negative patients, therefore it was not possible to write evidence statements.

6.2.3 From evidence to recommendations

The GDG felt there was no good evidence to support measures for infection control in patients with smear-positive disease not suspected to have MDR TB, whether or not HIV positive, and endorsed the guidance given in the BTS guideline.{68}

It is important to prevent unnecessary hospitalisation, as this is one of the major cost drivers for TB treatment. Treatment can proceed in the patient's home, considering that the household members will be contacted through contact tracing, and that infectiousness declines rapidly once treatment begins.

When children with TB are admitted to hospital, it is important to consider their visitors as likely close contacts, and to screen them when they visit as part of contact tracing, and also as infection control.

Given the unexpected data on negative pressure facilities from the review of current service (see 9.3.2), and similar findings in other surveys, the recommendations spell out the three categories of infection control, and require simple steps to clarify which rooms meet the agreed standards.

There can be conflicting guidance on whether staff should wear masks. It was agreed that masks are only required for MDR TB or during close contact in cough-inducing procedures, for example bronchoscopy and sputum induction. Patients are reassured by effective infection control measures, but are also often worried unnecessarily by masks or gowns, especially if these steps are not explained to them. The only role for patients wearing masks was within the first two weeks of treatment (when the patient remains infectious) and when they are outside their single room, for example going for an X-ray (as they may come into contact with other, susceptible, patients).

Readers should be aware of relevant guidance available from the Health and Safety Executive.{104}

6.2.4 RECOMMENDATIONS

The recommendations below deal with three levels of isolation for infection control in hospital settings:

- *negative pressure rooms, which have air pressure continuously or automatically measured, as defined by NHS Estates*{105}
- *single rooms that are not negative pressure but are vented to the outside of the building*
- *beds on a ward, for which no particular engineering standards are required.*

R33 All patients with TB should have risk assessments for drug resistance (see section 9.1) and for HIV. If risk factors for MDR TB are present, see section 9.3 for recommendations on infection control. D(GPP)

R34 Unless there is a clear clinical or socioeconomic need, such as homelessness, people with TB at any site of disease should not be admitted to hospital for diagnostic tests or for care. D(GPP)

R35 If admitted to hospital, people with suspected respiratory TB should be given a single room. D(GPP)

R36 Patients with respiratory TB should be separated from immunocompromised patients, either by admission to a single room on a separate ward, or in a negative pressure room on the same ward. D(GPP)

R37 Any visitors to a child with TB in hospital should be screened as part of contact tracing, and kept separate from other patients until they have been excluded as the source of infection. D(GPP)

R38 Smear-positive TB patients without risk factors for MDR TB (see section 9.1) should be cared for in a single room, until: D(GPP)

- they have completed two weeks of the standard treatment regimen (see section 6.1), or
- they are discharged from hospital.

R39 Aerosol-generating procedures such as bronchoscopy, sputum induction or nebuliser treatment should be carried out in an appropriately engineered and ventilated area for: D(GPP)

- all patients on an HIV ward, regardless of whether a diagnosis of TB has been considered
- all patients in whom TB is considered a possible diagnosis, in any setting.

2006

R40 Healthcare workers caring for people with TB should not use masks, gowns or barrier nursing techniques unless: D(GPP)

- MDR TB is suspected
- aerosol-generating procedures are being performed.

When such equipment is used, the reason should be explained to the person with TB. The equipment should meet the standards of the Health and Safety Executive. See section 9.3 for further details of MDR TB infection control.

R41 TB patients admitted to a setting where care is provided for people who are immunocompromised, including those who are HIV-positive, should be considered infectious and, if sputum smear-positive at admission, should stay in a negative pressure room until: D(GPP)

2006, amended 2011

1. the patient has had at least two weeks of appropriate multiple drug therapy, *and*
2. if moving to accommodation (inpatient or home) with people who are immunocompromised, including those who are HIV-positive, the patient has had at least three negative microscopic smears on separate occasions over a 14-day period, *and*
3. the patient is showing tolerance to the prescribed treatment and an ability and agreement to adhere to treatment, *and either*
4. any cough has resolved completely, *or*
5. there is definite clinical improvement on treatment, for example remaining afebrile for a week.

For people who were sputum smear negative at admission (that is, three negative samples were taken on separate days; samples were spontaneously produced

sputum if possible, or obtained by bronchoscopy or lavage if sputum samples were not possible): *all* of 1, 2, 3 and 5 above should apply.

R42 Inpatients with smear-positive respiratory TB should be asked (with explanation) to wear a surgical mask whenever they leave their room until they have had two weeks' drug treatment. D(GPP)

Cross-referring:

For details of managing drug-resistant TB, see chapter 9.

For details of contact tracing among hospital inpatients, see section 12.7.

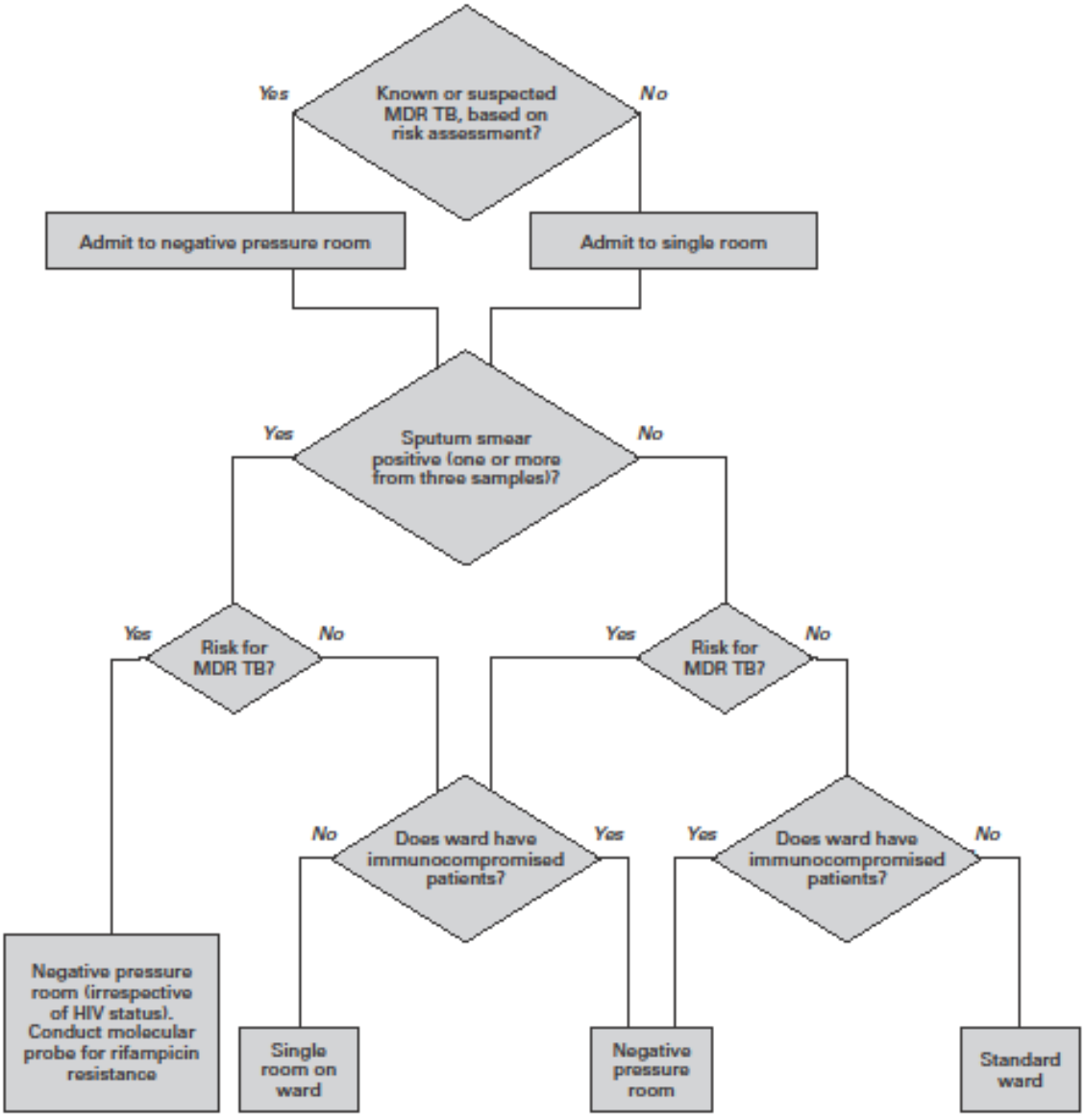


Figure 2: Algorithm showing isolation decisions for patients with suspected respiratory TB

7 Management of non-respiratory tuberculosis

7.1 Meningeal tuberculosis

7.1.1 Clinical introduction

Tuberculous meningitis occurs when there is blood-borne spread of the TB bacteria to the brain. In the days before treatment was available this usually occurred within 12 months of the original (primary) infection.{106} It is sometimes part of a more widespread blood-borne dissemination, with chest X-ray patterns typical of miliary tuberculosis.{107} It can present with systemic features if due to miliary disease, or more local central nervous system signs if limited to the brain. Unlike acute bacterial meningitis with, for example, the meningococcus, the onset of TB meningitis is insidious over a few weeks. In infants there may be non-specific symptoms such as not feeding or a failure to thrive. There can be headache and vomiting, then increasing drowsiness, and localised neurological signs such as cranial nerve palsies or hemiparesis, progressing to coma.

Clinically, the meningitis is classified according to the following stages:

- stage I: no clouding of consciousness or focal neurological signs
- stage II: clouding of consciousness and/or focal neurological signs
- stage III: coma.{108}

The diagnosis is supported by lumbar puncture suggesting CSF changes: a low glucose, raised protein and a lymphocyte dominant pattern of white blood cells. Diagnosis is confirmed by demonstrating *M. tuberculosis* on microscopy or culture of the CSF, or demonstrating *M. tuberculosis* DNA by PCR testing. TB meningitis may be accompanied by tuberculomas, inflammatory masses in the brain, which can either be present at diagnosis on CT brain scan or develop during treatment.{109} Although only approximately 100 cases of TB meningitis occur in England and Wales each year, this form of TB has a high morbidity and mortality when compared to nearly all other forms of non-respiratory tuberculosis.{110} Disability and death can still occur despite early diagnosis and appropriate treatment.

7.1.2 Methodological introduction: duration of treatment in adults

Studies were included where the majority of patients were adults (16 years of age and over) and where a modern drug treatment regimen was used to treat TB meningitis. Thus, treatment had to include at least isoniazid, rifampicin and pyrazinamide.

Two cohort studies performed in Turkey{111} and Thailand{112} were identified which compared different durations of treatment for TB meningitis. Two case series performed in Thailand{113} and Ecuador{114} and one treatment arm of a study performed in India{115} were also considered. All of the studies were completed more than 15 years ago and were excluded due to methodological limitations.

There is a lack of high-level evidence in this area. There are no RCTs which compare different durations of treatment for TB meningitis and there are no good quality cohort studies. This seems to be due to the relative rarity of the condition (small patient numbers in studies) and the associated high mortality and morbidity. The studies that do exist are plagued by a number of methodological problems including small sample size, a lack of generalisability due to completion in developing countries, patients in variable stages of clinical severity, problems with definitive diagnosis of TB meningitis, concurrent use of glucocorticoid therapy and a lack of inferential statistics. Due to the low quality of the studies in this area, it was not possible to write evidence statements.

7.1.3 Methodological introduction: duration of treatment in children

One systematic review of case series studies{116} was identified. This compared studies of six months treatment duration for TB meningitis with those of more than six months treatment duration. Nine studies were included, four of which were in the six months duration group{113},{114},{117},{118} and five in the more than six months duration group.{111},{119–123} Approximately 75% of the patients included were children. The review had several methodological limitations and due to these issues, the studies included in this review and performed in children were assessed separately. These were two studies performed in India,{120},{122} one in Thailand{117} and another in South Africa;{118} however all of these studies were excluded on the basis of methodological limitations.

Within the area of treatment duration for TB meningitis in children (as with adults) there is a lack of high-level evidence. Studies had similar methodological limitations to those in adult populations. Additionally, the issue of generalisability of results to the UK was even more marked as one study reported high levels of childhood malnutrition.{122} Due to the low quality of the studies in this area, it was not possible to write evidence statements.

7.1.4 Methodological introduction: glucocorticoids as an adjunct to antituberculous drugs

A Cochrane systematic review{124} compared the effects of glucocorticoids in combination with anti-TB treatment with anti-TB treatment alone in patients with TB meningitis. The review consisted of six RCTs{125–130} and was methodologically sound and hence it could technically be given a grading of 1++/1+. However, the methodological limitations of individual studies contained within the review meant that there was insufficient robust data from which to derive evidence statements. The authors of the review concluded that

'adjunctive steroids might be of benefit in patients with TB meningitis. However, existing studies are small, and poor allocation concealment and publication bias may account for the positive results found in this review'.

In the study steroids were associated with fewer deaths (RR 0.79, 95%CI 0.65 to 0.97) and a reduced incidence of death and severe residual disability (RR 0.58, 95%CI 0.38 to 0.88). Subgroup analysis suggested an effect on mortality in children (RR 0.77, 95%CI 0.62 to 0.96) but the results in a smaller number of adults were inconclusive (RR 0.96, 95%CI 0.50 to 1.84).

Another systematic review{131} was also appraised; however this was excluded due to methodological limitations.

One further RCT was identified.{132} This was a very high-quality study performed in Vietnam in adults and included patients who were HIV positive.

Studies were excluded where glucocorticoids were administered intrathecally as this rarely occurs due to the necessity of a lumbar puncture. This was the approach taken in the Cochrane systematic review.{124}

Due to the methodological issues associated with the studies in the Cochrane review{124} there is no sound evidence available for the use of corticosteroids in children with TB meningitis. There is also no compelling evidence in this area for HIV-positive patients.

7.1.5 Evidence statements

Mortality and severe residual disability

In a RCT performed in Vietnam{132} in TB meningitis patients over 14 years of age, adjunctive treatment with dexamethasone was associated with a reduced risk of death (RR 0.69, 95%CI 0.52 to 0.92, p=0.01). It was not however associated with a significant reduction in the proportion of severely disabled patients or in the proportion of patients who either died or were severely disabled after nine months.{132} (**1++**)

Disease severity and HIV status

The treatment effect of adjunctive dexamethasone was consistent across subgroups that were defined by:

- disease severity grade (stratified RR of death, 0.68, 95%CI 0.52 to 0.91, p=0.007){132}
- HIV status, although the reduction in the risk of death was not significant (the number of HIV-infected patients was too small to confirm or reject confidently a treatment effect).{132} (**1++**)

Adverse effects

Significantly fewer serious adverse events occurred in the dexamethasone group than in the placebo group (26 of 274 patients *vs*. 45 of 271 patients, p=0.02). In particular eight severe cases of hepatitis (one fatal) occurred in the placebo group and none occurred in the dexamethasone group (p=0.004).{132} (**1++**)

7.1.6 From evidence to recommendations

The evidence base in this area is hampered by the difficulty of recruiting patients for participation in studies. Mostly the existing studies included people following a presumptive diagnosis with few positive culture confirmations.

There is no evidence to support treatment durations of less than 12 months, but all the evidence on duration has some methodological limitations. Given the serious

risk of disability and mortality, the advice given in the 1998 BTS guidelines{68} remains appropriate.

There is also no evidence to inform the choice of drugs. Caution is required with ethambutol in unconscious patients, streptomycin should be avoided in pregnancy if at all possible (fetal 8th nerve damage) and there is potential teratogenicity with ethionamide and prothionamide.{133}

The important factor in drug choice was penetration into CSF. Ethionamide, isoniazid, prothionamide and pyrazinamide achieve best penetration. Rifampicin is less good in this regard, and ethambutol and streptomycin only penetrate into CSF if the meninges are inflamed.

Given the potential severe effects of neurological damage arising from TB meningitis, and the strong evidence in adults from the Vietnam study{132} supporting additional glucocorticoids, this guideline recommends them. There is no reason to give a high-dose glucocorticoid to most patients, and the GDG reached a consensus on reviewing treatment response after 2–4 weeks with a view to starting to withdraw the glucocorticoid as soon as it is safe to do so.

7.1.7 RECOMMENDATIONS

R43 Patients with active meningeal TB should be offered:

- a treatment regimen, initially lasting for 12 months, comprising isoniazid, pyrazinamide, rifampicin and a fourth drug (for example, ethambutol) for the first two months, followed by isoniazid and rifampicin for the rest of the treatment period D(GPP)
- a glucocorticoid at the normal dose range
  - adults equivalent to prednisolone 20–40 mg if on rifampicin, otherwise 10–20 mg. A
  - children equivalent to prednisolone 1–2 mg/kg, maximum 40 mg D(GPP)

with gradual withdrawal of the glucocorticoid considered, starting within 2–3 weeks of initiation. D(GPP)

R44 Clinicians prescribing treatment for active meningeal TB should consider as first choice:

- a daily dosing schedule B
- using combination tablets. D

Cross-referring:
For details of standard drug treatment, see section 6.1.
For details of managing drug-resistant TB, see chapter 9.

7.2 Peripheral lymph node tuberculosis

7.2.1 Clinical introduction

Lymph node TB is an important form of non-respiratory TB accounting for nearly half of all non-respiratory sites{26},{27} (see epidemiology in Appendix G). Since non-respiratory disease is found less commonly in white UK-born people than in others, who now make up nearly 70% of all cases in the UK, the number of cases of lymph node disease seen is rising.

Trials by the BTS and its predecessors with regimens of 18 months,{134} nine months{134},{135} and six months duration,{135–137} all showed a significant proportion of cases (up to 40%) to have residual nodes at the end of treatment, and up to 10% at 30 month follow-up. Sometimes new nodes and occasionally sinuses develop during treatment and/or during follow-up. Nearly all of these events are thought to be immunologically mediated responses to residual tuberculo-proteins, and not failure to respond to treatment or relapses. When cultured there is seldom evidence of bacteriological activity.

7.2.2 Methodological introduction

A meta-analysis{138} of studies of varying designs compared six-month treatment regimens with nine month regimens in people with peripheral lymph node TB. However, this was excluded due to methodological limitations.

Two RCTs identified in the meta-analysis were assessed seperately.{137} One UK trial comparing six months *vs.* nine months daily treatment was reported in two papers firstly as preliminary results{136} and then follow-up results at 30 months.{137} The other trial performed in Hong Kong{139} compared six months

and nine months thrice-weekly treatment, however this was excluded due to limitations in methodology.

There was a lack of high-quality comparative studies in this area, thus only one has been included as evidence.{136},{137}

7.2.3 Evidence statements

A UK RCT{136},{137} of patients with peripheral lymph node TB compared two nine-month drug regimens (2HRE/7HR and 2HRZ/7HR) and one six-month regimen (2HRZ/4HR). Of those patients seen at 30 months (85%), there was no statistically significant difference between the groups in terms of reported residual measurable nodes, relapse, enlargement of existing nodes, development of new glands or sinuses or the need for new operative procedures. Aspiration after commencement of treatment was performed in eight patients: seven on the 2HRE/7HR regimen and the other on 2HRZ/4HR (2HRE/7HR versus all HRZ, p=0.005). (**1+**)

7.2.4 From evidence to recommendations

There was little evidence to guide the GDG in more practical issues, but it was felt that treatment should be stopped at the end of the regimen regardless of the appearance of new nodes, residual nodes or sinuses draining.

One study{136},{137} of six months *vs.* nine-months treatment duration shows equivalence for fully susceptible organisms. However, this trial used a three-drug initial phase (2RHZ), which may be inadequate in view of current drug resistance rates,{140} and the isoniazid resistance rate of 12% in the trial.{136},{137} The standard six-month, four-drug regimen is therefore recommended.

Drug treatment is still required even if a gland has been surgically removed, because of the possibility of residual local and distal TB foci. Surgical excision biopsy for histology and culture is advised if pus cannot be aspirated from a gland. Fine needle aspiration does not give adequate samples for TB culture.

7.2.5 RECOMMENDATIONS

R45 For patients with active peripheral lymph node tuberculosis, the first choice of treatment should:

- be the standard recommended regimen (see section 6.1 for further details) B

- use a daily dosing schedule B
- include combination tablets. D

R46 Patients with active peripheral lymph node TB who have had an affected gland surgically removed should still be treated with the standard recommended regimen. D(GPP)

R47 Drug treatment of peripheral lymph node TB should normally be stopped after six months, regardless of the appearance of new nodes, residual nodes or sinuses draining during treatment. D(GPP)

Cross-referring:
For details of standard drug treatment, see section 6.1.
For details of managing drug-resistant TB, see chapter 9.

7.3 Bone and joint tuberculosis: drug treatment

7.3.1 Clinical introduction

Spinal TB accounts for approximately half of all the sites of bone and joint TB seen in England and Wales.{22},{26},{27} As such it is an important subset of non-respiratory disease, and one which can sometimes have significant morbidity because of spinal cord compression from extradural abscess and/or vertebral collapse. For these reasons, the GDG considered the evidence base on the medical management of spinal TB as a proxy for the management of the many possible joint sites, in which separate drug trials have not been conducted.

7.3.2 Methodological introduction

Three RCTs were identified which compared different durations of treatment in those with TB of the spine.

A Hong Kong study{141} with fourteen years of follow-up compared six, nine and eighteen months of treatment in those who had undergone radical anterior resection with bone grafting. The results of this trial (without the 18 month arm) were also reported at five years in a paper that presented the results of two further trials at five years in Madras and Korea,{142} which both compared six months of treatment with

nine months in patients who had not received surgery. The Madras trial was also reported with follow-up at ten years.{143} The Korean trial{142} was excluded due to a number of methodological limitations.

These trials were all originally commenced in the 1960s and 1970s by the British Medical Research Council (MRC) and although they subscribed to the methodological standards of the time, they do not include all patients in the analyses in the groups to which they were originally allocated (ie an intention to treat analysis). In line with NICE guidance in circumstances where an intention to treat analysis has not been used and there is little evidence available, these studies have been evaluated as if they were non-randomised cohort studies.

These studies did not use the standard, four-drug initial treatment regimens currently used in the UK and none of the studies reported blinding methods.

7.3.3 Evidence statements

In a Hong Kong study{142} at five years follow-up, all analysed patients who had received radical anterior resection with bone grafting and a six- or nine-months treatment regimen of isoniazid, rifampicin and streptomycin (except one in each group) had favourable status at five years, and most had achieved favourable status by three years. (Favourable status was defined as full physical activity with radiographically quiescent disease, with neither sinuses nor clinically evident abscesses and with no myelopathy with functional impairment and no modification of the allocated regimen). (**2+**)

In the Hong Kong study{141} at 14 years follow-up, clinical outcomes were similar in the six-, nine-and 18-month treatment regimen groups. One patient in the six months group had minor motor deficits whereas one patient in the 18 months group had partial unilateral sensory deficits. No patients had bladder or bowel disturbances at final follow-up and there was no recurrence or reactivation of tuberculosis in either group. Additionally there were no statistically significant differences in the change in mean angle of deformity between the groups and most side effects occurred early in treatment and were not related to duration of treatment. (**2+**)

In a study in Madras{142} of patients who received treatment (isoniazid and rifampicin) without surgery for six or nine months, 91% in the six-month group and 98% in the nine-month group had a favourable status at five years (using the same definition as the Hong Kong study{142}). At ten years{143} there was no significant difference in favourable status, or occurrence of complete bony fusion. The angle of kyphosis increased in both regimens with no significant difference between groups; however, in patients less than 15 years of age with angle of kyphosis >30°, the mean increase by ten years was 30°, compared with 10° in those >15 years (p=0.001). (**2++**)

7.3.4 From evidence to recommendations

A number of trials were conducted in association with the British MRC between the 1960s and 1980s in Korea, India and Hong Kong, designed according to the standards of the time. Whilst they did not use intention to treat analysis, these studies on six, nine and 18 months of treatment, with extensive follow-up of up to 10 years in some cases, show that six months duration of treatment performed just as well as longer regimens. The GDG agreed that these results are likely to be applicable to other forms of bone and joint tuberculosis, and accordingly recommended the standard six-month, four-drug regimen.

The GDG acknowledged the risk of CNS involvement via the spinal cord, and recommended scans to check for any patient with neurological signs or symptoms. The was no evidence to guide a choice of either CT or MR scanning.

7.3.5 RECOMMENDATIONS

R48 The standard recommended regimen (see section 6.1 for details) should be planned and started in people with:

- active spinal TB B
- active TB at other bone and joint sites. C

R49 Clinicians prescribing treatment for active bone and joint tuberculosis should consider as first choice:

- a daily dosing schedule B
- using combination tablets. D

See section 6.1 for details.

R50 CT or MR scan should be performed on patients with active spinal TB who have neurological signs or symptoms. If there is direct spinal cord involvement (for example, a spinal cord tuberculoma), management should be as for meningeal TB (see section 7.1). D(GPP)

Cross-referring:
For details of managing drug-resistant TB, see chapter 9.

7.4 Bone and joint tuberculosis: routine therapeutic surgery

7.4.1 Clinical introduction

From before the age of anti-tuberculosis treatment, immobilisation and bed rest were thought to be important for bone and joint tuberculosis. This view continued after the development of anti-tuberculosis drugs and into the time when shorter durations of treatment with newer drugs were available. A series of studies by the MRC, commencing in 1965, showed the respective roles of anti-tuberculosis treatment and other routine management measures in spinal tuberculosis. Studies in Korea found no benefit from routine bed rest,{144},{145} or of a plaster jacket during therapy,{145},{146} and in Rhodesia no benefit from routine initial debridement of lesions.{147} Prior to the introduction of rifampicin, trials of radical anterior fusion showed mixed results.{142},{148–151} The advent of rifampicin led to further trials on the use of anterior spinal fusion in conjunction with short-course treatment regimens.

7.4.2 Methodological introduction

Two RCTs were identified which compared surgery and drug treatment for those with TB of the spine with drug treatment alone.

A study in Rhodesia{149} compared debridement and drug treatment with drug treatment alone but was excluded for methodological issues.

A Madras study, reporting at five{142} and ten years,{143} compared radical resection with bone grafting plus six months' treatment with isoniazid and rifampicin with just six or nine months' treatment with isoniazid and rifampicin.

The Madras trial, whilst in line with the methodological standards at the time it was commenced, did not include all patients in the analysis in the group to which they had been originally allocated (ie an intention to treat analysis). In line with NICE guidance in circumstances where an intention to treat analysis has not been used and there is little evidence available, these studies have been evaluated as if they were non-randomised cohort studies. Furthermore, it should be noted that a two-drug regimen would not now be used in the UK as standard therapy.

7.4.3 Evidence statements

At five years,{142} radical resection with bone grafting in addition to six-months treatment regimen (with isoniazid and rifampicin) showed no benefit in status (favourable status was defined as no sinus or clinically evident abscess, no myelopathy and no modification of allocated regimen, no limitation of physical activity due to spinal lesion and radiologically quiescent disease) compared to six- or nine-months treatment regimen alone. (**2++**)

Whilst at ten years,{143} the surgery and six-months treatment regimen was less effective in terms of favourable status than the nine-month treatment regimen alone ($p=0.03$), the difference being due to surgical complications. However, patients in the surgery and anti-tuberculosis drug treatment group had a faster resolution of sinuses and/or clinically evident abscesses ($p<0.001$ at two months) and a lower incidence ($p=0.03$) than those in the anti-tuberculosis drug treatment only groups. There was no significant differences found between the groups in terms of occurrence of complete bony fusion or angle of kyphosis. There were four deaths associated with spinal tuberculosis (all within the first six months and all in the surgery and anti-tuberculosis drug treatment group). Three died in the postoperative period and the other had complications of postoperative paraplegia. (**2++**)

7.4.4 From evidence to recommendations

Although the GDG concluded that the evidence showed no additional advantage of routinely carrying out anterior spinal fusion over standard chemotherapy, the

recommendations for spinal surgery cannot be extrapolated to bone/joint tuberculosis at other sites.

Aspiration of paraspinal abscesses and/or biopsy from spinal sites may be needed for the diagnosis of TB, which is different from routine anterior fusion. Forms of surgery such as aspiration or arthroscopy of joints may be needed to obtain material for histology and culture by which to make the diagnosis of tuberculosis in bone/joint sites other than the spine.

7.4.5 RECOMMENDATIONS

R51 In patients with spinal TB, anterior spinal fusion should not be performed routinely. B

R52 In patients with spinal TB, anterior spinal fusion should be considered if there is spinal instability or evidence of spinal cord compression. D(GPP)

7.5 Pericardial tuberculosis

7.5.1 Clinical introduction

TB of the pericardium accounts for less than 4% of non-respiratory TB in England and Wales,{140} but is potentially important because of the possibilities of cardiac tamponade and constrictive pericarditis, which have a mortality and morbidity higher than most other forms of extrapulmonary TB.

The presence of a pericardial effusion may require aspiration by pericardiocentesis for diagnosis, repeated during treatment. Similarly, considerable pericardial thickening, with or without fluid, may require surgery with pericardectomy or a pericardial window, which is a major invasive intervention. Additional glucocorticoids tailing from the equivalent of prednisolone 60 mg/day have been recommended in the UK,{68} following studies in Transkei, South Africa, where this form of active tuberculosis was particularly common,{152},{153} which appeared to show reduced morbidity and mortality.

7.5.2 Methodological introduction

A Cochrane systematic review{154} attempted to compare six-month anti-tuberculosis drug treatment regimens with regimens of nine months or more in

people with tuberculous pericarditis. The Cochrane review search did not identify any RCTs which compared anti-tuberculosis drug regimens of these different durations.

No further studies were identified which compared six months of treatment with longer treatment durations, thus it was not possible to write evidence statements on the duration of treatment for TB pericarditis.

Two systematic reviews, which considered the effectiveness of glucocorticoids in addition to drug treatment in patients with TB pericarditis were identified. A Cochrane systematic review{154} considered this issue in addition to a number of other treatment issues in TB pericarditis (treatment duration, pericardial drainage and pericardectomy) whilst a review by the same authors, published elsewhere, only considered the issue of additional glucocorticoids for TB pericarditis.{155} The same four studies were included in both reviews{152},{153},{156},{157} and the results presented and the publication year were the same.

The two RCTs included in these reviews by Strang{152},{153} have since been reported at ten years.{158} Results from this new report which now includes an intention to treat analysis, along with the two other RCTs identified in the systematic reviews, have thus been considered separately. One of these studies was excluded on methodological grounds.{156} The other study included HIV-positive patients only.{157}

TB pericarditis is relatively rare and so it is difficult to find enough patients to study; furthermore, it is also difficult to diagnose. For example, the study in HIV patients{157} was small (N=58) and the TB diagnosis was confirmed by culture in only 38% of the participants.

7.5.3 Evidence statements

The results of RCTs performed in Transkei, South Africa, comparing prednisolone to placebo in pericardial effusion and pericardial constriction patients with or without drainage are presented in the table below.{158}Table 29 also includes the results of an RCT comparing prednisolone *vs*. placebo in HIV-positive pericardial effusion patients.{157}

Table 29 Summary of evidence for pericardial TB

TB pericardial effusion without open drainage	**Evidence**
	• Prednisolone reduced the need for repeat pericardiocentesis, which was required in 10% of prednisolone patients and 23% of placebo patients (p=0.025).{158}
	• Adverse outcomes of any type were significantly less frequent in the prednisolone than the placebo group, occurring in 19% compared with 40% respectively (p=0.003).{158}
TB pericardial effusion with/without open drainage	**Evidence**
	• Adverse outcomes occurred in 52% with neither open drainage nor prednisolone, *vs*. 14% drainage and prednisolone, 11% drainage and placebo and 19% prednisolone and no drainage (p=0.08 for interaction).{158}
TB pericardial effusion HIV positive	**Evidence**
	• Survival was significantly improved in the prednisolone group compared with the placebo group when patients were followed up for 18 months (p=0.004). However, although steroids were associated with fewer deaths, this was not statistically significant if the timing of the deaths was not taken into account (RR 0.5, 95%CI 0.19 to 1.28).{157}
	• Improvement in physical activity (p=0.02) and resolution of raised jugular venous pressure (p=0.017), hepatomegaly (p=0.007) and ascites (p=0.051) were faster in prednisolone-treated patients than those given placebo.{157}
	• There was no difference in the rate of radiologic and echocardiographic resolution of pericardial effusion, the risk of constrictive pericarditis or the frequency of steroid-related complications between the prednisolone and placebo groups.{157}
TB pericardial constriction	**Evidence**
	• There were no significant differences in adverse outcomes or deaths from pericarditis between prednisolone and placebo groups.{158}
Any pericarditis	**Evidence**
	• In a multivariate survival analysis (stratified by type of pericarditis), prednisolone reduced the overall death rate after adjusting for age and sex (p=0.044) and substantially reduced the risk of death from pericarditis (p=0.004).{158}

7.5.4 From evidence to recommendations

The group were not aware of any further evidence on the treatment regimen and concluded that first-line treatment is with the standard six-month, four-drug regimen.

2006

There are no comparative studies on which to base recommendations on the duration of treatment. Since this is a pauci-bacillary form of extrapulmonary disease by extrapolation from other forms of extrapulmonary disease with more evidence, a six-month duration of treatment is expected to be effective.

The GDG agreed that the RCT evidence{157},{158} strongly supported the use of glucocorticoids in adults with active pericardial tuberculosis and that they were also likely to be beneficial in children.

7.5.5 RECOMMENDATIONS

R53 For patients with active pericardial TB, the first choice of treatment should:

- be the standard recommended regimen (see section 6.1 for details) B
- use a daily dosing schedule B
- include combination tablets. D

R54 In addition to anti-TB treatment, patients with active pericardial TB should be offered:

- for adults, a glucocorticoid equivalent to prednisolone at 60 mg/day. A
- for children, a glucocorticoid equivalent to prednisolone 1 mg/kg/day (maximum 40 mg/day)

with gradual withdrawal of the glucocorticoid considered, starting within two to three weeks of initiation. D(GPP)

Cross-referring:
For details of managing drug-resistant TB, see chapter 9.

7.6 Disseminated (including miliary) tuberculosis

7.6.1 Clinical introduction

In the 1997 guidance on notification, it was suggested that those with non-specific symptoms started on TB treatment should be described as having 'cryptic disease' with the term 'cryptic miliary disease' being reserved for those where the organism has been isolated from blood, from bone marrow or from multiple organ systems. In clinical texts there is usually a distinction between 'classical miliary' disease with the diffuse 1–2 mm uniform micronodular chest X-ray from acute haematogenous

spread which may also involve other organs, including the CNS, and 'cryptic miliary' where the patient may have fever but few localising signs. The data collection form for enhanced TB surveillance gives possible sites of TB, including miliary and cryptic disseminated. Cryptic disseminated is defined as 'systemic illness without localising features'.

These different labels for forms of what is essentially blood-borne spread of tuberculosis can cause confusion. Essentially, blood-borne spread may or may not be accompanied by chest X-ray or high-resolution CT changes. Such blood-borne spread often also causes significant liver function derangement because of diffuse liver involvement. This is a serious form of TB with a significant morbidity and mortality, so the risks of treating the disease with drugs which have a low incidence of hepatic side effects (3%), are much less than those of leaving the patient inadequately treated. The meninges are also not infrequently involved as part of the blood-borne spread, with up to 30% having clinical or lumbar puncture evidence of such involvement.{140} The detection of CNS disease is important because of the longer duration of treatment required for CNS involvement.

7.6.2 Methodological introduction

One retrospective study{159} where patients with disseminated TB received three different durations of treatment was identified, however this was excluded due to small sample size (N=6).

No other comparative studies were found, hence it was not possible to write evidence statements.

7.6.3 From evidence to recommendations

No data were found to inform recommendations. It is noted that all sites outside the CNS for which data exist show adequate response to a six-month, four-drug initial treatment regimen, but that six-month regimens have not been shown to be adequate for those with CNS involvement (see section 7.1).

Exclusion of CNS disease is important, by CT scan, MRI or lumbar puncture, so that the correct duration of treatment is applied.

Abnormal liver function should not prevent or delay the commencement of TB treatment, which usually causes improvement in liver function abnormalities due to the disease itself.

7.6.4 RECOMMENDATIONS

R55 For patients with disseminated (including miliary) TB, the first choice of treatment should:

- be the standard recommended regimen (see section 6.1 for details) B
- use a daily dosing schedule B
- include combination tablets. D

R56 Treatment of disseminated (including miliary) TB should be started even if initial liver function tests are abnormal. If the patient's liver function deteriorates significantly on drug treatment, advice on management options should be sought from clinicians with specialist experience of these circumstances. D(GPP)

R57 Patients with disseminated (including miliary) TB should be tested for CNS involvement by:

- brain scan (CT or MRI) and/or lumbar puncture for those with CNS signs or symptoms
- lumbar puncture for those without CNS signs and symptoms.

If evidence of CNS involvement is detected, treatment should be the same as for meningeal TB (see section 7.1). D(GPP)

Cross-referring:
For details of managing drug-resistant TB, see chapter 9.

7.7 Other sites of infection

7.7.1 From evidence to recommendations

There is no evidence base available to derive recommendations for other sites of infection. However, as the pathogen and its drug susceptibility is the same, treatment has generally been given with the same regimen as is used for respiratory

tuberculosis. The GDG's clinical experience supported this and hence the recommendation below is extrapolated from the evidence base for respiratory tuberculosis, and other non-respiratory sites.

7.7.2 RECOMMENDATION

R58 For patients with:

- active genitourinary TB, or
- active TB of any site other than:

– respiratory system
– CNS (typically meninges)
– peripheral lymph nodes
– bones and joints
– pericardium
– disseminated (including miliary) disease

the first choice of treatment should:

- be the standard recommended regimen (see section 6.1 for details) B
- use a daily dosing schedule B
- include combination tablets. D

Cross-referring:
For details of managing drug-resistant TB, see chapter 9.

8 Monitoring, adherence and treatment completion

8.1 Treatment completion and follow-up

8.1.1 Clinical introduction

In the UK, when the recommended regimen has been given to patients with fully susceptible organisms, the rate of relapse is low (0–3%) in both trial{69} and clinical practice conditions,{160} if there has been good adherence with treatment. Under these circumstances, it is important to know whether routine follow-up after treatment completion is cost-effective in detecting relapse.

8.1.2 Methodological introduction

No studies were identified which compared the detected relapse rates of previously treated TB patients who were subject to routine follow-up, with a group who did not receive routine follow-up.

However, there were five case series which reported the proportion of relapsing patients who were identified as a relapse case during routine follow-up appointments and the number of cases who self-referred outside routine follow-up due to onset of symptoms or who were referred by their general practitioner (GP) or detected after an admission for another initial diagnosis. Two studies were conducted in the UK,{161},{162} two in the USA{163},{164} and one in India.{165}

Many of the studies found were performed 20 to 30 years ago, prior to the advent of modern treatment regimens. These studies generally concluded that routine follow-up was unnecessary, which may explain the dearth of studies on routine follow-up for previously treated TB patients since this time. In addition, the definition of relapse varied across studies and in all the studies (apart from one where it is not clear{164}) only patients with pulmonary TB were included.

8.1.3 Evidence statements

Detection by routine follow-up

In five case series studies of previously treated TB patients found to have relapsed, the percentage detected at routine follow-up clinic attendances were 27%,{165} 35%,{164} 40%,{163} 51%{161} and 58%{162} (one study{165} only included patients who had completed treatment). (**3**)

One study calculated that routine surveillance of 1,000 patients who had completed treatment would help to identify approximately six relapses in one year{165} whilst a yield of 0.6% of relapse cases detected from routine follow-up was calculated in another study.{164} (**3**)

Rate of relapse

In a UK study the relapse rate at five years since the start of treatment was 3.5%.{162} In another study 4% of patients with active TB added to a TB register over a 7.5-year period had been diagnosed with reactivated disease{163} whilst in

the Indian study the authors calculated a cumulative relapse rate of 11.6% at five years in patients who completed treatment.{165} (**3**)

Risk factors for relapse

Of the patients who relapsed in a UK study, 82% discharged themselves prematurely from hospital and/or terminated their own treatment.{162} In another study 75% of relapsed patients over a 7.5-year period had a combined treatment regimen which was self-interrupted or self-discontinued and a further 14% received no treatment or streptomycin only.{163} An Indian study{165} found the main reason for prolongation of treatment was irregular drug taking during the course of treatment. Patients who completed their course of treatment in less than 24 months had an overall relapse rate of 4.09 % in five years; those who required 24 to 30 months had a cumulative relapse rate of 10.85% ($p<0.05$). (**3**)

In a group of relapsed chronic sputum-positive patients, 57% had inadequate duration of treatment regimen (less than 18 months) and a further 23% had adequate duration but irregular treatment.{161} In another study 61% of relapsed patients were not treated for the recommended treatment duration of 18 months.{162} Of a group of relapsed patients detected during routine follow-up, 49% had inadequate treatment (<1 year) with an effective regimen, or interruption of treatment serious enough to make the possibility of at least one year of continuous treatment unlikely.{164} Of these relapsed patients, 94% were found to have 'complicating factors' which included inadequate therapy, alcoholism or poor cooperation. (**3**)

In one study{162} the relapse rate in men was nearly twice that in women and was also higher in patients over 45 years. The relapse rate did not seem to be related to the extent of the disease. In another study of treatment completion patients the cumulative five-year relapse rate did not differ significantly between men and women or in terms of age or extent of initial disease, initial cavitary status or presence of drug-resistant bacilli.{165} (**3**)

The mean time between last positive sputum smear and relapse in patients treated after 1955 (when adequate therapy was employed) was 7.5±4.88 years.{161} (**3**)

2006

8.1.4 From evidence to recommendations

All patients should receive 'inform and advise' information upon treatment completion. They should then inform other healthcare professionals, who may provide or organise their care in the future, of their history of latent TB or disease.

Routine follow-up was felt to be necessary for MDR TB, and worth considering for isoniazid-resistant TB, because these patients have received non-standard treatment with a potentially higher relapse rate.

The GDG felt that regular follow-up clinic visits were unnecessary. Patients should be advised to be alert to symptoms and to contact the TB service rapidly.

8.1.5 RECOMMENDATIONS

R59 Follow-up clinic visits should not be conducted routinely after treatment completion. D

R60 Patients should be told to watch for symptoms of relapse and how to contact the TB service rapidly through primary care or a TB clinic. Key workers should ensure that patients at increased risk of relapse are particularly well informed about symptoms. D(GPP)

R61 Patients who have had drug-resistant TB should be considered for follow-up for 12 months after completing treatment. Patients who have had MDR TB should be considered for prolonged follow-up. D(GPP)

Cross-referring:
For examples of 'inform and advise' information, see Appendix H.

8.2 Improving adherence: directly observed therapy

8.2.1 Clinical introduction

People with TB can either be given treatment to take without supervision (self-administered therapy) or under direct observation by a health professional or other person such as a family member, where the swallowing of the medication is observed. The latter is known as directly observed therapy. Intermittent (less often than daily) dosing regimens lend themselves to DOT because of the lower

frequency of dosing to supervise. The monitoring of DOT is however only one part of the WHO DOT strategy,{166} which has five elements.

1. Supervised medication taking.
2. Drug availability including reserve drugs.
3. Sputum testing facilities with quality control.
4. Patient tracking systems.
5. Political commitment at Governmental level.

The WHO advocates universal DOT as part of their overall strategy, the aim being to increase treatment completion rates to over 85%, which particularly for smear-positive pulmonary disease, is the level above which modelling shows that case numbers then begin to decrease. Treatment completion rates of over 90% however have been reported from both the USA and UK using mainly self-administered therapy and only selective – not universal – DOT.{160},{167}

Sceptics who have labelled DOT as 'supervised pill swallowing'{168} say that the success of DOT programmes is derived from the substantial technical and financial investment in tuberculosis programmes that the DOT strategy represents and not the DOT element itself.{169}

DOT is commonly used in the UK, as the 1998 BTS guidelines{68} recommended, for patients who are unlikely to comply, those with serious mental illness, patients with multiple drug resistances, and for those with a history of non-adherence with anti-tuberculosis medications, either in the past or documented during treatment monitoring. For those without multiple drug resistances, a three-times weekly regimen was recommended.

8.2.2 Current practice

Of the TB service providers participating in the review of current services, 79% in London and 80% elsewhere used DOT. Some of the other respondents stated that it was not needed. There was no obvious variation in the provision of DOT by notifications, personnel or specialist personnel, nor was there any correlation

between the number of patients given DOT and the number of notifications, personnel or specialist personnel. It would seem that the variation in practice is due to different clinical habits. Given the cost of DOT, it would seem timely to promote a consistent and evidence-based approach to its provision.

8.2.3 Methodological introduction

Three systematic reviews{170–172} and four additional RCTs{173–176} were identified comparing DOT with self-administered treatment. Two systematic reviews{171},{177} and one RCT{175} were excluded due to methodological limitations. The included studies were a Cochrane systematic review of six RCTs (four studies of patients being treated for active TB conducted in Thailand,{178} Pakistan{179} and South Africa{180},{181} and two US studies of individuals receiving preventive therapy for latent TB{182},{183}) plus a US study of homeless patients{176} and a study of illegal immigrants in Italy{174} both with latent TB on prophylaxis, and a study of active TB patients in Australia.{173}

Numerous elements of a DOT programme may affect cure and treatment completion rates and therefore it is difficult to isolate the contribution of observing the patient taking their TB medication. For example, the relationship a patient has with their observer or the distance of the clinic from a patient's home are integral parts of a DOT programme which may influence outcomes. This also means that due to the number of elements which may differ within a DOT programme and cultural differences between populations, it is difficult to generalise from one setting to another. The way it is possible to offer DOT services will be dependent on the way healthcare systems are configured and the resources available. DOT services may differ in terms of:

- hospital or clinic versus home-based DOT
- observers may be lay persons (community or family members who may or may not have received training or advice on DOT) or healthcare professionals (doctors, nurses or health visitors)
- DOT may be given throughout treatment or for only part of it
- DOT may be introduced with other (less explicit) elements which may affect outcomes, for example new enthusiastic staff, education, incentives (food, drink, travel vouchers etc), counselling or psychosocial support.

None of the studies identified were performed in the UK.

In terms of who should observe DOT, six RCTs comparing different types of DOT observers were identified. The studies were performed in Tanzania,{184},{185} Pakistan,{179} the USA,{176} Swaziland{186} and South Africa.{181}

A number of different types of observers are used in the studies and may not necessarily be comparable across studies. These were:

- a volunteering community member selected by a village leader who was interviewed and trained by a health worker, compared with observation by a health worker in the nearest health centre{185}
- a trained guardian (family member) or former TB patient compared to a health worker in a health facility{184}
- a health worker at a health facility where a patient met access criteria to the facility, compared with supervision by a family member who was orientated in the role{179}
- a lay health worker in the lay health worker's home compared with observation by a nurse at a clinic{181}
- a trained family member compared with a community health worker{186}
- a research assistant observing homeless patients at a study site with a $5 incentive compared with observation by a trained, paid, homeless peer health advisor.{176}

In the US study,{176} the monetary incentive in the research assistant observer arm meant that the contribution of the observer to this result was unclear.

Additional factors for consideration include the duration of supervision (this was only for the first two months in the studies in Tanzania{184},{185}), variable motivation and training of observers and the convenience of the site of the observation. None of the studies were UK based.

With regard to terminology in this area, in recent years use of the term compliance has been discouraged due to its connotations of patient subservience. The term adherence has instead been used to describe the patient's choice as to whether to complete treatment. More recently the term concordance has been recommended

2006

to reflect 'the active exchange of information, negotiation, and spirit of cooperation'.{187}

8.2.4 Evidence statements

Efficacy of DOT

A Cochrane systematic review{172} found that patients allocated to DOT compared to self-administered treatment had similar outcomes in relation to cure and cure plus treatment completion based on a meta-analysis of four RCTs of patients with tuberculous disease.{178–181} In terms of population groups where DOT may be effective, only one of these RCTs (in sputum positive TB patients over 15 years of age with no previous treatment history for TB{178}) significantly favoured DOT (in terms of both cure (RR 1.13, 95%CI 1.04 to 1.24) and cure plus treatment completion (RR 1.11, 95%CI 1.03 to 1.18) compared with self-administered treatment. However, this study allowed participants to choose their supervisor and involved home visits by health workers every two weeks. (**1++**)

In an RCT of homeless patients in the USA{176} on prophylaxis for latent TB, no significant difference was found in treatment completion between a peer health advisor performing DOT and usual care (self-administered treatment). Treatment completion in a monetary incentive arm however (where DOT was provided by a trained research assistant and patients were given a monetary incentive at each visit), was significantly better than in the usual care arm (p=0.04). Residence in a hotel or other stable housing at entry into the study *vs.* residence on the street or in a shelter at entry was an independent predictor of treatment completion (OR 2.33, 95%CI 1.00 to 5.47). (**1++**)

In illegal immigrants on prophylaxis for latent TB{174} in Italy, those on supervised (directly observed clinic-based) treatment were significantly less likely to complete treatment than did those on an unsupervised regimen (p=0.006, log rank test). Treatment completion rates were 7.3% in the supervised group and 26% in the unsupervised group. (**1++**)

In an Australian RCT,{173} when comparing a family based programme of DOT for active TB patients with standard supervised but non-observed therapy no significant difference was found in relation to treatment completion or non-adherence. (**1+**)

Observers for DOT

None of three strategies tested in patients with active TB in Pakistan{179} (self-supervision, health worker DOT and family member DOTS) was superior to the others in terms of cure rate or cure rate and treatment completion combined. (**1++**)

In homeless patients in the US{176} on prophylaxis for latent TB, completion in the research assistant observer with monetary incentive arm was significantly better than in the peer health advisor arm (44% *vs*. 19%, p=0.01). (**1++**)

In patients treated for active TB in Tanzania,{185} no significant difference in biological conversion rate at two months or cure at seven months was found between institutional-based directly observed treatment and community-based directly observed treatment. (**1+**)

The cure rate and the treatment success rate (cure and treatment completion) for smear-positive patients in Tanzania{184} was not significantly different under community DOT (by a family member or former TB patient) compared with health facility-based DOT. (**1+**)

In new smear-positive patients in Swaziland,{186} there was no significant difference in cure rate or cure and completion rate between community health workers' and family members' DOT. (**1+**)

Treatment outcomes (cure combined with treatment completion) in South African{181} patients with active TB were not significantly different in the lay health worker supervision group compared to clinic DOT. (**1+**)

8.2.5 From evidence to recommendations

The generalised application of DOT is shown to be effective in only one study,{178} which allowed participants to choose their supervisor and also involved home visits by health workers every two weeks. One study in homeless men (street- or shelter-dwelling) in the USA indicated that, for street homeless men, financial incentives with personal support and/or more secure accommodation is associated with higher completion rates of treatment of latent TB infection when given as DOT. Studies in Australia and Italy did not show improved outcomes for those in the DOT arms. There is no high-level UK evidence in this area.

The interventions involved in DOT are not just supervised taking of medicines, but include increased contact and support. Given the resources required for DOT, and the attendant opportunity costs, the GDG decided not to recommend DOT for the general TB population. Improved adherence in both DOT and routine care may be achieved through more frequent contact with healthcare professionals.

Contamination between treatment arms in any DOT trial may have caused underestimated efficacy. In order to provide DOT, the infrastructure and culture of TB services changes (in particular, the emphasis given to ensuring treatment is completed). These changes may also have affected the control arms of studies. No trials have yet been conducted using designs to eliminate this effect.

There are also concerns about the outcomes which are necessarily used in these trials. Treatment completion and/or microscopy conversion are the outcomes used in trials to date, but the outcomes DOT aims to prevent are development of drug resistance and relapse of disease. Existing trials have neither the necessary long-term follow-up, nor are powered to look directly at these outcomes.

The model of DOT administered is also not optimum in most RCTs, for example if patients are sometimes expected to travel large distances for their treatment rather than DOT being available at the most convenient location. The only trial that allowed patients to have an input into where DOT was administered did find a beneficial effect. This is an issue of applicability for trials conducted in developing countries.

The GDG could not reach unanimity on making a recommendation to limit the use of DOT, but agreed that it is not useful in the UK as a universal mode of TB treatment, and consequently set out to recommend groups in whom DOT may be useful, and for whom it should be considered on an individual basis.

The GDG felt that evidence was sufficient to require a recommendation on DOT for street- or shelter-dwelling homeless people. The GDG did not feel able to make a recommendation to use DOT routinely for people with histories of alcoholism, drug abuse or mental illness.

One of the studies considered{176} indicates some effect of stable housing on adherence. Considering this and the multifaceted support contained within DOT programmes, the GDG regarded it as crucial to DOT's success that environmental and psychosocial factors, and the pragmatic patient-centred delivery of DOT, be considered at the start of the patient's treatment.

2006

8.2.6 RECOMMENDATIONS

R62 Use of DOT is not usually necessary in the management of most cases of active TB. A All patients should have a risk assessment for adherence to treatment, and DOT should be considered for patients who have adverse factors on their risk assessment, in particular:

- street- or shelter-dwelling homeless people with active TB B
- patients with likely poor adherence, in particular those who have a history of non-adherence. D(GPP)

R63 Clinicians who are planning to offer a course of DOT should consider ways to mitigate the environmental, financial and psychosocial factors that may reduce adherence, including stability of accommodation, prescription charges and transport. The setting, observer and frequency of treatment should be arranged to be most practicable for the person with TB. The person with TB and his or her assigned key worker should be involved in deciding these arrangements. DOT should also be supported by frequent contact with the key worker (see 8.3). D(GPP)

2006, amended 2011

8.3 Improving adherence: non-pharmacological strategies

2006

8.3.1 Clinical introduction

With regard to terminology in this area, in recent years use of the term compliance has been discouraged due to its connotations of patient subservience. The term adherence has instead been used to describe the patient's choice as to whether to complete treatment. More recently the term concordance has been recommended to reflect 'the active exchange of information, negotiation, and spirit of cooperation'.{187}

Concordance on TB treatment has been recognised as an issue for many years.{188} Problems can arise with both physicians' adherence with recommended

regimens and with patients' adherence with the agreed treatment.{189},{190} Adherence is the single most important determinant of treatment outcome, with poor adherence being strongly associated with treatment failure and relapse.{72} Strategies to improve adherence with treatment are therefore very important in those patients taking self-administered treatment. Any measure which increases adherence is therefore likely to improve outcome, by increasing the cure and completion rate, and reducing the failure rate of treatment and the relapse rate after treatment completion.

8.3.2 Current practice

Improving adherence

Participants in the review of current services were asked about incentives and measures to improve adherence to therapy, including free prescriptions.

94% of clinics in London, and 73% of participants outside London, reported using some measures to improve adherence. Most clinics reported using urine assays, examining urine colour, using tablet counts, and controlled dosage systems. Other respondents (outside London) also asked patients to sign care plans with regular support or gave the patients tablet diaries. Five responders outside London cited the use of home visits as a measure of improving adherence. There was no apparent variation by notifications, personnel or specialist personnel which might account for some clinics providing these while a few do not. As these simple measures appear to be almost universally used, and given the potential benefits, it seems appropriate that all clinics have some such measure available, unless their work is only in screening, vaccination or contact tracing.

61% of clinics in London, and 19% of participants outside London, used incentives to increase clinic attendance. Respondents mainly reported refunding travel costs, but others stated were food and prizes for children. Three clinics (all in London) offered cash. There was no obvious variation by notification rates in the clinics using incentives outside London, although there may be a trend in London toward high-notification clinics using incentives. This may explain the contrast in use between London and the rest of England and Wales. There was no obvious variation by personnel or specialist personnel.

2006

Only 16% of participants outside London had free prescriptions. Within London, this figure was 67%. The contrast between London and elsewhere may be because within London, the use of free prescriptions appeared to be related to the clinics that had more nursing staff.

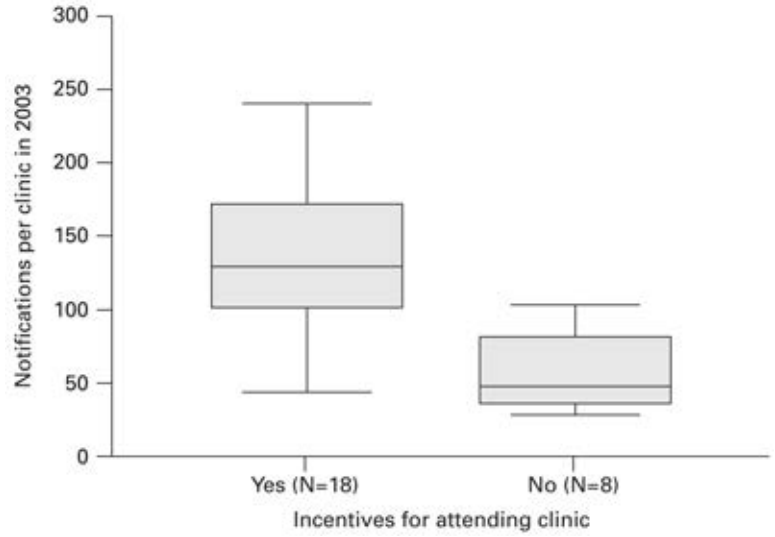


Figure 5 Box plot of notifications of TB per clinic in London, by use of incentives

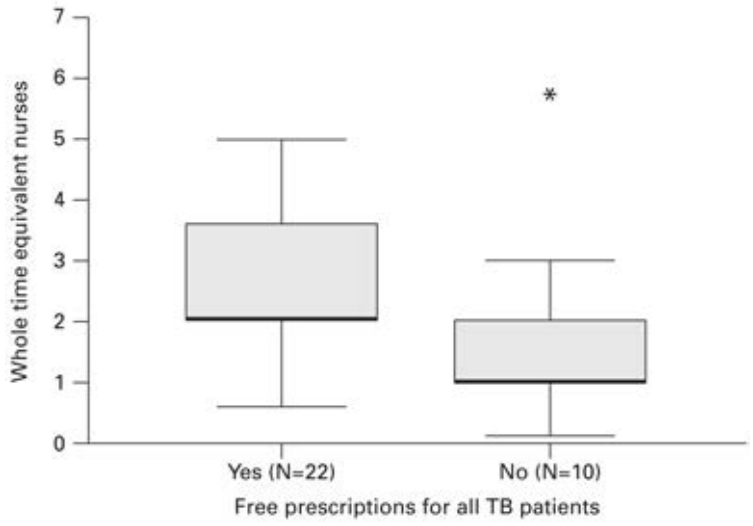


Figure 6 Box plot of notifications of TB per clinic in London, by use of free prescriptions

Outreach work

Some form of outreach was carried out by 67% of clinics outside London. Within London, this was 82%. Most outreach was to patients' homes. Some respondents reported outreach in care homes, detox shelters and other drug treatment venues,

homeless shelters, clubs and other community centres and places of work. Variation in the provision of outreach work was not obviously explained by caseload (notifications), staffing levels or availability of specialist personnel.

8.3.3 Methodological introduction: adherence among patients on treatment for active TB

A systematic review{191} examined the evidence from five randomised trials of the effectiveness of various strategies to promote adherence. The review included two trials of patients with active TB,{192},{193} two trials of those on prophylactic drug treatment for latent TB{194},{195} and one trial which included both groups.{196} As the review included trials of both patient groups and did not attempt statistically to combine the results, it was thought that it would be more informative to evaluate the trials on an individual basis.

In terms of strategies to promote adherence in those with active TB, a trial performed in India{193} compared outcomes in those defaulters who failed to collect their drugs and then did or did not receive reminder letters. Two studies included in the systematic review,{191} performed in Korea{192} and the USA{196} were excluded due to methodological limitations.

Three further RCTs were found. Another Indian study compared two policies of default management{197} while a trial performed in Pakistan{198} studied the impact of intensive counselling on treatment outcomes. A third RCT{199} was excluded due to methodological issues.

Two cohort studies and a case control study were also identified. A cohort study performed in South Africa{200} assessed whether the combined strategy of a patient-centred interview plus the issuing of a patient education booklet would increase adherence to treatment. The other cohort study{201} was excluded due to methodological limitations as was the case control study.{202}

Strategies to promote adherence may be specific to their setting, population or treatment (in terms of drug, dose and duration) and thus not generalisable. No studies were identified which had been performed in UK populations.

8.3.4 Methodological introduction: adherence among patients on prophylactic drug treatment for latent TB

With regard to strategies to promote adherence in those with latent TB, the systematic review{191} on adherence strategies for TB treatment included two trials of those on prophylactic drug treatment for latent TB.{194},{195}

One of these studies in a homeless population{194} was excluded on the basis that the only outcome measure was adherence to first referral. The other study{195} however was excluded on the basis of methodological limitations.

Five further studies were found that were not included in the systematic review.{191} One of these was excluded due to methodological limitations.{203}

Of the four remaining studies, all were American trials. Two studies{204},{205} were in adolescents (mainly of Latino origin). One{204} looked at the effects of adherence coaching, self-esteem counselling and usual care on treatment completion. In the other study{205} peer counselling, parent participant contingency contracts, both of these interventions combined and usual care interventions were assessed. Another study{206} was in prisoners released whilst on TB prophylaxis who received either education or the promise of an incentive (a food or travel voucher) when attending the TB clinic. The final study was in a community-based population of homeless adults who received either a cash or non-cash incentive of equivalent value when attending their TB clinic appointments.{207}

Few high-quality trials have been completed, and where there are studies, these are in very specific non-UK population groups raising generalisability concerns. Furthermore, in these studies it is often difficult to assess the contribution of increased attention and motivation from healthcare professionals or other individuals, rather than an intervention itself, which may have been responsible for improved outcomes.

8.3.5 Evidence statements

Active disease

In a study conducted in India{193} a significantly higher treatment completion rate (88%) was achieved among a group of patients who received reminder letters when

2006

they defaulted (failed to collect their TB medication) in comparison to patients in a group where no action was taken for default (73%) (p<0.001). (**1+**)

The default rate of the intervention group in a Pakistani study{198} who received monthly health education counselling was 46.6% which was significantly lower compared to 53.6% in the control group (RR 0.87, 95%CI 0.77 to 0.98, p=0.03). (**1+**)

Two policies of default management were compared in an Indian study.{197} Under routine policy, failure to collect TB drugs within three days resulted in a reminder letter and then a home visit on the 11th day and then no further action, whilst under the intensive policy, home visits were made on the same day and followed by further visits at one and two months. No statistically significant difference was found. (**1+**)

In a study conducted in South Africa,{200} the relative risk of being non-adherent to treatment at the control clinic (standard clinic treatment) compared to the intervention clinic (where patients received a patient-centred interview and a health education booklet in addition to standard clinic treatment) was 4.3 (95%CI 1.3 to 14.5, p=0.014). (**2+**)

Latent infection

In teenage people of Latino origin in the USA on treatment for latent TB,{204} the coaching condition (where bilingual Latino college students were trained to provide education concerning latent TB and treatment) had the highest cumulative mean number of pills consumed over six months (129.27), and members of the coaching group took significantly (p<0.05) more pills than members of the usual care (113.09) and self-esteem groups (112.02) (in the latter bilingual Latino college students served as self-esteem counsellors). Treatment completion however, was not significantly different between the three groups. (**1+**)

In a study performed in the USA of adolescents on treatment for latent TB,{205} treatment completion rates did not vary significantly across study groups. Treatment was completed by 84.8% of participants in the combined intervention group (peer counselling and incentives), 80.3% in the peer counselling group (adolescents who had completed therapy for latent TB were recruited and trained as peer

counsellors), 77.8% receiving usual care (treatment and educational services customarily provided by the clinic) and 76.4% in the incentive group (parents and adolescents negotiated an incentive provided by the parent to be received if the adolescent adhered to the prescribed TB treatment). (**1+**)

In US prisoners released whilst on treatment for latent TB,{208} rates of completion of therapy were 23% in the education group (where patients were seen every two weeks for the duration of their stay, to reinforce initial information), 12% in the incentive group (patients were able to choose food or transport vouchers of equivalent cash value if they went to the TB clinic within one month of release) and 12% in the control group (where there was no further contact with study personnel). Those in the education group were more than twice as likely as those in the control group to complete treatment (adjusted OR 2.2, 95%CI 1.04 to 4.72, p=0.04), whereas treatment completion in the incentive group did not significantly differ from the controls. (**1+**)

In a community-based population of homeless adults in the USA on TB prophylaxis,{207} no statistically significant difference in completion was found between those in a cash arm (89%) who received a monetary incentive for keeping each twice-weekly medication appointment and those in the non-cash incentive arm (81%), who could choose fast-food or grocery store coupons, telephone cards or bus tokens with an equivalent face value. (**1++**)

8.3.6 From evidence to recommendations

It is important to involve the patient in treatment decisions, and emphasise the importance of adherence through education in an appropriate language.

In the GDG's experience, useful adherence strategies include:

- reminder letters in appropriate languages
- supervision and support from healthcare workers
- home visits
- patient diaries
- urine tests and other monitoring (for example, pill counts) during visits by a nurse or health visitor

- an appropriately trained and experienced named key worker
- assisting or advising patients regarding links to social security benefits and housing/social services.

Involvement of primary care professionals throughout a course of anti-tuberculosis drugs may also promote adherence.

Prescriptions for people with TB are not free in all parts of England and Wales. This clearly complicates the work of clinicians trying to improve adherence to therapy. The Chief Medical Officer's TB Action Plan{2} sets as one of its essential actions to improve TB services 'explore ways of reducing the cost of TB drugs to patients, and of facilitating their dispensing'. The GDG considered this issue but it is not the role of NICE guidelines to address charges for NHS services at the point of delivery, and no recommendation has been made.

It is important to ensure the availability of liquid drug preparations, to assist treatment of children or people who have swallowing difficulties. However, it should be noted that pharmacies may need up to a week to access these medicines in liquid form and therefore there is a need to ensure prescriptions are written in advance of the patient's current supply running out. If a community pharmacist is involved in the supply of these drugs then discharge summaries/clinic letters and prescriptions will need to be provided to the community pharmacist at the earliest opportunity to ensure a continuous supply.

The GDG considered the difference demonstrated in default rate in one of the studies,{198} while statistically significant, to be small and clinically insignificant. Another study{208} had shown a significant difference in completion rates but both groups had rates that would be very poor in a UK context.

Recommendations are also given here to assist adherence through patient and public information (see chapter 4 for further details). Patient and public information is available in many languages.

8.3.7 RECOMMENDATIONS

R64 To promote adherence, patients should be involved in treatment decisions at the outset of treatment for active or latent TB. The importance of adherence should

be emphasised during discussion with the patient when agreeing the regimen. D(GPP)

R65 The TB service should tell each person with TB who their named key worker is, and how to contact them. This key worker should facilitate education and involvement of the person with TB in achieving adherence. D(GPP)

R66 TB services should consider the following interventions to improve adherence to treatment for active or latent TB if a patient defaults:

- reminder letters in appropriate languages B
- health education counselling B
- patient-centred interview and health education booklet B
- home visits D(GPP)
- patient diary D(GPP)
- random urine tests and other monitoring (for example, pill counts) D(GPP)
- information about help with paying for prescriptions D(GPP)
- help or advice about where and how to get social security benefits, housing and social services. D(GPP)

R67 Pharmacies should make liquid preparations of anti-TB drugs readily available to TB patients who may need them – for example children and people with swallowing difficulties. D(GPP)

R68 TB services should assess local language and other communication needs and, if there is a demonstrated need, provide patient information accordingly.[11] D(GPP)

2006

[11] Patient information should be drawn from national high-quality resources if available; for examples, see www.hpa.org.uk or www.nks.nhs.uk

9 Risk assessment and infection control in drug-resistant TB

9.1 Risk factors

9.1.1 Clinical introduction

Drug resistance is an important issue in the management of TB, as it may prolong the period during which patients are infectious to others as well as compromising the effectiveness of treatment. Resistance to particular single drugs develops in individual bacteria by natural mutations in between one in 10^5 and one in 10^7 organisms, depending upon the drug in question. Multiple drug combinations overcome this problem provided enough drugs are given and taken correctly, but modification of the treatment may be required. Resistance to TB drugs is defined as a level of resistance to four times or greater the concentration of drug required to inhibit a fully susceptible organism.

Resistance can be acquired, in a patient with a fully susceptible organism, by inadequate drug treatment being prescribed (physician error) and/or inadequate adherence with treatment (patient error). Resistance can be also be primary, with a patient being infected with an already drug-resistant organism, thus having drug resistance without a prior treatment history. Resistance can be to a single drug, for example mono-resistance to isoniazid, or to multiple drugs, for example to both isoniazid and streptomycin. MDR TB is defined as high-level resistance to both rifampicin and isoniazid with or without additional drug resistances.

Controlled clinical trials for respiratory tuberculosis show that 100% of cases positive on microscopy and culture pre-treatment have become negative on culture after four months of standard treatment.{209} Positive cultures after four months treatment, ie in month five or later, therefore by definition represent treatment failure.{210} Cases of treatment failure have a high chance of having developed acquired drug resistance, which can be rapidly assessed with molecular probes for rifampicin resistance and a repeat drug susceptibility profile.

MDR TB is important because there is loss of both the main bactericidal drug (isoniazid) and the main sterilising drug (rifampicin). The consequences of this

situation are considerable. Such patients who are sputum smear positive remain infectious for much longer than those with susceptible organisms, have a higher death rate from, and a lower cure rate for, their tuberculosis, require individualised complex regimens using multiple reserve drugs of higher toxicity, and cost at least £50,000–70,000 each to treat.{211}

Drug resistance in TB is found in nearly all settings in the world, but some countries or areas have higher levels of drug resistance and MDR TB than others. Drug resistance in England, Northern Ireland and Wales has been monitored continuously by MycobNet, based at the Centre for Infections, Colindale (see chapter 14 for details). This information is available at www.hpa.org.uk

International monitoring of drug resistance is undertaken by the WHO and IUATLD.{212} Russia and the Baltic states recently joining the European Union (Estonia, Latvia and Lithuania) have had high levels of MDR TB (>5% of all cases) reported, as have Argentina, Côte D'Ivoire, Dominican Republic, Iran, and some parts of China and India.

9.1.2 Methodological introduction

Studies were sought that examined risk factors for any type of drug resistance or MDR TB. However, if the study population was dissimilar to the UK the studies were excluded. Thus studies from most developing countries were excluded except those in sub-Saharan Africa and India or Pakistan, as these represent significant ethnic minority groups in the UK. Other studies from Japan, Taiwan, or localised areas of the USA and European countries were excluded as these were felt not to be representative of the ethnic mix of the UK population. National studies undertaken in European countries were included.

Thirteen studies were identified which met the above criteria. Four of these studies were analyses of drug resistant TB in the UK,{213–216} four studies were performed in sub-Saharan Africa,{215},{217–220} and additionally there were studies undertaken in the USA,{221} France,{222} The Netherlands,{223} Switzerland{224} and India.{225} Two studies (one in sub-Saharan Africa and one in India) were excluded due to methodological limitations.{217},{225}

Most studies reported national surveillance data and were graded as level 2 as they involved significant comparative analysis even if they did not fall strictly into a case control study design type. It should be noted that the UK studies which cover notified TB cases over the same time period will include the same cases in their analyses.

The retrospective nature of these studies often means data about some risk factors is not recorded in detail or at all, so there may be incomplete risk factor data. This is especially true of HIV status, which for many patients is often unknown.

To aid comparison, the number of participants included in each study is indicated.

9.1.3 Evidence statements

All evidence statements are graded level 2+.

Table 30: Risk factors

Study	Association
Age as a risk factor	
UK national surveillance study{213} (N=25,217)	A slightly higher proportion of isoniazid resistance (7.6%) was observed in those aged 15–44 years than in other age groups. This was significantly higher than in those aged >44 years for isoniazid resistance only and significantly higher than in those aged >65 years for MDR TB.
UK study based in one London hospital{214} (N=121)	Patients with drug-resistant TB were younger than those with drug-sensitive TB (OR 1.03, 95%CI 1.02 to 1.05, p<0.001). The mean age of those with resistance to more than one first-line drug was 40 years, resistance to only one first-line drug was 32 years and drug-sensitive TB was 47.4 years.
National US study{221} (N=67,340)	Those who were younger than 65 years were at increased risk of drug resistance to at least isoniazid with adjusted OR 1.7 (95%CI 1.4 to 2.2) for those aged 0–14 years, 2.0 (95%CI 1.8 to 2.2) for those aged 15–24 years, 1.8 (95%CI 1.6 to 1.9) for ages 25–44 years and 1.4 (95%CI 1.3 to 1.6) for those aged 45 to 64 years.
National surveillance study in Switzerland{224} (N=1,056)	An increased risk of resistance to any first-line drug was associated with being <65 years of age (adjusted OR 1.5, 95%CI 1.0 to 2.3).
National surveillance study in the Netherlands{223} (N=1,836), a surveillance study in Kenya{218}	No significant association was found between age and drug resistance.

2006

(N=491) and two South African studies{219},{220} (N=7,266 and N=275 respectively)	
Prior treatment history as a risk factor	
UK national surveillance study{213} (N=25,217)	Those reported to have had a previous episode of TB, exhibited a significantly higher proportion of resistance to at least isoniazid (15.5%) and MDR (9.4%) than either those patients who had never had TB (5.7% and 0.8% respectively), or those whose history regarding previous TB was not available (4.9% and 0.7%, respectively; p<0.001 (isoniazid resistance); p<0.001 (MDR)).
UK study of TB patients in England and Wales reported during two time periods (1993 to 1994 and 1998 to 2000){216} (N=9,541)	There was a strong association between previous treatment and MDR TB (OR 9.1, 95%CI 6.3 to 13.2). This overall relationship was weaker for isoniazid resistance (OR 1.6, 95%CI 1.2 to 2.1).
UK study based in one London hospital{214} (N=121)	The highest risk for resistance to any drug was associated with previous treatment for TB (OR 22.85, 95%CI 5.1 to 102.5; p<0.001).
UK study in Leicestershire{215} (N=104)	Previous history of TB (OR 3.7, 95%CI 1.2 to 11.8, p=0.022) was significantly associated with resistance to at least one first line drug.
National US study{221} (N=67,340)	For resistance to any drugs and the combination of isoniazid and rifampin (MDR TB), the rate of resistance was higher among patients with prior TB compared with those without prior TB (p<0.05). Those with prior TB were at increased risk of resistance to at least isoniazid with an adjusted OR of 2.6 (95%CI 2.4 to 2.9).
French national surveillance study{222} (N=2,998)	An increased risk of resistance to any drug (OR 2.7, 95%CI 2.0 to 3.8) and MDR TB (OR 10.2, 95%CI 4.1 to 25.3) was associated with previous history of treatment. Similarly, unknown treatment history was associated with an increased risk of resistance to any drug (OR 1.7, 95%CI 1.2 to 2.5) and MDR TB (OR 3.4, 95%CI 1.1 to 11.2).
National surveillance study in the Netherlands{223} (N=1,836)	Rates of acquired resistance (those who had been previously treated for TB) to isoniazid alone (11.4%) and isoniazid and rifampicin (MDR TB, 5.7%) were higher than rates of primary resistance (those who had never been diagnosed with TB before) to these drugs (5.2% and 0.7% respectively, p<0.05)
National surveillance study in Switzerland{224} (N=1,056)	An increased risk of resistance to any first-line drug was associated with previous history of treatment (adjusted OR 7.3, 95%CI 3.9 to 13.6).
Surveillance study of 26 districts in Kenya{218} (N=491)	Of 90.6% of patients with no history of previous treatment, 6.3% had a resistant strain while of 9.4% with a previous history of anti-

2006

	tuberculosis drug treatment, 37% had a resistant strain (p<0.005).
South African study analysing rates of drug resistance in the West Cape region{219} (N=7,266)	Patients with a history of TB treatment were found to be at an increased risk of developing drug resistance (RR 2.6).
South African study based in one hospital{220} (N=275)	No significant association was found between previous treatment history and drug resistance.
Previous TB status in addition to other risk factors	
In a UK study of TB patients reported during two time periods (1993 to 1994 and 1998 to 2000){216} (N=9,541)	In those with previous TB, significant risk factors for isoniazid resistance were smear positive status (OR 3.2, 95%CI 1.1 to 9.2) and being of non-UK origin but arriving in the UK in the past 10 years (OR 3.2, 95%CI 1.4 to 7.0). This was similar for MDR TB where the most significant risk factors were smear positive disease (OR 5.9, 95%CI 1.8 to 19.0) and non-UK origin – particularly those who had arrived in the last five years in whom the risk compared with UK-born was approximately sixfold (OR=0.58, 95%CI 1.8 to 18.5). In those without previous TB, significant risk factors for isoniazid resistance were London residence (OR 1.4, 95%CI 1.1 to 1.7), being HIV positive (OR 2.4, 95%CI 1.1 to 5.2) although this was only significant in 1993 to 1994 (OR 2.4, 95%CI 1.1 to 5.2), and ethnicity. Compared with the white ethnic group, adjusted odds ratios were similar in people of Indian (subcontinent) origin (OR 1.6, 95%CI 1.2 to 2.1), people of black African origin (OR 1.7, 95%CI 1.2 to 2.4) and other ethnic groups combined (OR 1.9, 95%CI 1.3 to 2.8). For MDR TB the most significant risk factors were being HIV positive (OR 2.5, 95%CI 1.2 to 5.2) and London residence (OR 2.0, 95%CI 1.2 to 3.3). Birth outside the UK was also important, with the risk of MDR TB higher for those arriving in the last five years (OR 3.2, 95%CI 1.4 to 7.3).
Ethnicity as a risk factor	
UK national surveillance study{213} (N=25,217)	Among the three ethnic groups from whom substantial numbers of isolates were received, the highest proportion of resistance to at least isoniazid and MDR TB was reported in isolates from people of black African origin (10.1% and 2.0% respectively) with 7.2% and 1.4% in those originating from the Indian subcontinent, and 4.1% and 1.4% in those of white ethnic origin. Resistance to at least isoniazid was significantly different between all three ethnic groups (p<0.001).
UK study based in one London hospital{214} (N=7,266), Kenyan study{218} (N=491), South African study{219} (N=7,266)	No significant association was found between Caucasian and non-Caucasian ethnicity and drug resistance{214} and in the other two studies similarly no association was found

2006

	between drug resistance and ethnic group.	
Gender as a risk factor		
UK national surveillance study{213} (N=25,217)	The proportion of those resistant to at least isoniazid was higher in men (5.9%) than in women (5.4%), although the difference was not significant. However, men were significantly more likely to have MDR TB (1.4% *vs*. 0.9%, p<0.001).	
National surveillance study in Switzerland{224} (N=1,056)	Increased risk of resistance to any first-line drug was associated with male sex (adjusted OR 1.4, 95%CI 1.1 to 2.0).	
UK study based in one London hospital{214} (N=121), national surveillance study in the Netherlands{223} (N=1,836), Kenyan study{218} (N=419), two South African studies{219},{220} (N=7,266 and N=275 respectively)	No association was found between drug resistance and gender.	
Place of birth as a risk factor		
UK national surveillance study{213} (N=25,217)	People born outside the UK were significantly more likely to have resistance to at least isoniazid than those born in the UK (9.1% *vs*. 4.2%, OR 2.27, p<0.001). Similarly, 2.0% of people born outside the UK had an MDR isolate compared with 1.0% of those born in the UK (OR 1.97, p<0.001).	
National US study{221} (N=67,340)	Foreign-born cases had significantly higher rates of resistance to isoniazid (12.4% *vs*. 6.4%, p<0.05) and streptomycin (10.0% *vs*. 4.3%, p<0.05) than US-born case patients but similar rates of rifampin resistance (3.1% *vs*. 2.9%) and MDR TB (2.4% *vs*. 2.0%). Those who were foreign born were at increased risk of resistance to at least isoniazid with an adjusted OR 1.5, 95%CI 1.4 to 1.6.	2006
French national surveillance study{222} (N=2,998)	An increased risk of resistance to any drug (OR 1.7, 95%CI 1.3 to 2.2) and MDR TB (OR 2.7, 95%CI 1.1 to 6.2) was associated with foreign birth.	
National surveillance study in the Netherlands{223} (N=1,836)	Drug resistance was reported in 9% of patients born in the Netherlands and in 18% of foreign-born TB patients (p<0.001).	
National surveillance study in Switzerland{224} (N=1,056)	Foreign-born patients showed a slightly but not significantly elevated risk of resistance (adjusted OR 1.5, 95%CI 0.8 to 2.8).	
Two UK studies, (N=121){214} (N=104){215} and a Kenyan study {218} (N=491)	Drug resistance was not associated with foreign birth.	
Place of diagnosis as a risk factor		
UK national surveillance study{213} (N=25,217)	Compared with other English NHS regions and Scotland, Northern Ireland and Wales, patients diagnosed in London were more likely to have isolates resistant to at least isoniazid (7.6% *vs*. 4.6%, p<0.001). Similarly, patients from	

	London were more likely to have MDR isolates (1.7% *vs*. 0.9%, p<0.0001).
HIV status as a risk factor	
UK national surveillance study{213} (N=25,217)	Those known to be co-infected with HIV were more likely to be either resistant to at least isoniazid (11.6% *vs*. 5.5%) or be MDR (4.6% *vs*. 1.1%) than those from people of unknown or negative HIV infection status (p<0.001 (isoniazid resistance); p=<0.001 (MDR)).
National US study{221} (N=67,340)	For all drugs, resistance was significantly higher (p<0.05) in HIV-positive *vs.* HIV-negative patients and HIV-positive *vs*. those with unknown status, except for patients with isolates resistant to ethambutol. Those who were HIV positive were at increased risk of resistance to at least isoniazid with an adjusted OR 1.6 (95%CI 1.4 to 1.8).
French national surveillance study{222} (N=2,998)	An increased risk of resistance to any drug (OR 1.7, 95%CI 1.2 to 2.4) was associated with HIV positive status however an association was not found for MDR TB.
National surveillance study in the Netherlands{223} (N=1,836)	HIV positivity was more frequently reported in the drug-resistant group than in the drug-susceptible group (7.7% *vs*. 4.9%) but this difference was not significant.
South African study based in one hospital{220} (N=275)	No significant association was found between HIV status and drug resistance.
History of poor treatment adherence as a risk factor	
UK study in Leicestershire{215} (N=104)	Poor adherence (OR 4.8, 95%CI 1.4 to 14.4, p=0.005) was significantly associated with resistance to at least one first-line drug.
Other risk factors	
UK study based in one London hospital{214} (N=121)	Bilateral disease at presentation was associated with drug resistance (OR 8.5, 95%CI 2.1 to 35.0, p<0.005) but not with recent entry to the UK for foreign-born patients, alcoholism, psychological disturbances, homelessness, living in care homes or poor understanding of the English language (although for many of these risk factors patient numbers identified were very small).
UK study in Leicestershire{215} (N=104)	No significant associations were found between site of TB, foreign travel or recent immigration and resistance to at least one first-line drug (although it should be noted that only a small number of participants had these risk factors).
In a national surveillance study in the Netherlands{223} (N=1,836)	Asylum seekers diagnosed on arrival in the Netherlands showed an increased risk of resistance to any drug with 4.8% of cases in the drug-susceptible group and 10.4% in the drug-resistant group (p<0.001). With regard to site of disease and other clinical features (diabetes, malignancy and pregnancy) and a number of other risk groups (sailors, travellers,

2006

	illegal immigrants, the homeless, alcohol users, drug users, prisoners and healthcare workers), no differences were observed between the groups.

9.1.4 From evidence to recommendations

The GDG noted that the evidence base came from studies conducted in different parts of the world. The most significant risk factors depend on the population within which a drug-resistant strain is transmitted. Even factors found to be valid for London should not be extrapolated to the whole of England and Wales.

One of the UK studies{215} was noted to be a sub-population of the larger population-wide study.{213}

The data clearly show that there are a number of risk factors for drug resistance, which listed in order of importance for relative risk are as follows.

1. A history of prior TB drug treatment.
2. Birth in a foreign country, particularly sub-Saharan Africa and the Indian subcontinent.
3. HIV infection.
4. Residence in London.
5. Age profile, with highest rates between the ages of 25 and 44 years.
6. Male gender.

The GDG also regarded contact with a known case of TB, and treatment failure as risk factors.

It is still not known whether risk factors for MDR TB are the same as those for lesser forms of drug resistance.

Based on the conclusions of section 5.3, rifampicin-resistance molecular probes were recommended for those patients with risk factors.

The absence of risk factors is not enough in itself to remove clinical suspicion of drug-resistant TB.

The GDG agreed that intensive contact tracing should be carried out in all cases of MDR TB.

The GDG recognised the dangers associated with failure of drug treatment, and sought to advise readers that it needs to be recognised early.

9.1.5 RECOMMENDATIONS

R69 A risk assessment for drug resistance should be made for each patient with TB, based on the risk factors listed below: C

- History of prior TB drug treatment; prior TB treatment failure.
- Contact with a known case of drug-resistant TB.
- Birth in a foreign country, particularly high-incidence countries as defined by the HPA on its website.[12]
- HIV infection.
- Residence in London.
- Age profile, with highest rates between ages 25 and 44.
- Male gender.

R70 The TB service should consider the risk assessment for drug resistance and, if the risk is regarded as significant, urgent molecular tests for rifampicin resistance should be performed on smear-positive material or on positive cultures when they become available (see section 5.2). D(GPP)

R71 Response to treatment should be closely monitored in patients at increased risk of drug resistance. If there is no clinical improvement, or if cultures remain positive after the fourth month of treatment ('treatment failure'), drug resistance should be suspected and treatment reviewed with a clinician experienced in the treatment of MDR TB. D(GPP)

(See section 6.1 for details of the standard recommended regimen.)

2006

[12] Countries with more than 40 cases per 100,000 per year, as listed by the Health Protection Agency go to www.hpa.org.uk and search for 'WHO country data TB'.

9.2 Referral

9.2.1 Clinical introduction

MDR TB comprises some 0.8–0.9% of culture-confirmed TB cases in the UK, mainly in England and Wales.{140} As such they represent only 30–40 cases per year in number, but they have disproportionate importance because of:

- a prolonged infectious potential in pulmonary disease
- the need for higher levels of infection control, with negative pressure ventilated side wards, because of this and the potential adverse effects of acquiring the organism
- a much greater cost to treat, a minimum of £50–70,000 per case{211}
- prolonged treatment, often requiring multiple second-line drugs with an increased toxicity profile
- worse cure and survival rates, in both HIV-negative and HIV-positive individuals{226–230}
- the risk to healthcare workers and other contacts if they become infected.

Because treatment is complex, time consuming and demanding on both the patient and the physician, practice to date, based on BTS guidelines for treatment,{68} has been that treatment is only carried out:

- by physicians with substantial experience in drug-resistant TB
- in hospitals with appropriate isolation facilities (a negative pressure room)
- in close conjunction with the HPA and HPA regional centres for mycobacteriology.

Clinical management of these cases is not addressed by this guideline, as it is a rare, highly specialised and highly individualised activity, which may include second-line drugs, close monitoring, full supervision of treatment and surgical options. It is therefore the concern of this guideline to promote transfer of patients to an appropriate unit.

9.2.2 Methodological introduction

A retrospective cohort study{231} performed in the USA was identified, which examined the treatment experience of patients diagnosed with MDR TB who were managed for at least part of their time on treatment in a specialist TB hospital. This study was excluded due to limitations in the methodology.

No studies of sufficient quality were found pertaining to whom (or where) MDR TB patients should be referred in order for them to achieve the most favourable treatment outcomes. Therefore, no evidence statements have been made in this section.

9.2.3 From evidence to recommendations

The GDG were aware that there are still relatively few cases of MDR TB in the UK each year, but noted that this represents a vitally important area in TB control and a unique challenge for treatment. The GDG felt that treatment failure (non-concordance) is a significant risk factor for drug resistance.

People with MDR TB are not always treated under the care of an MDR TB specialist. It was felt that there had been no evidence to support change in current practice in MDR TB referral since the BTS's code of practice.{6}

Patient acceptability and shared care arrangements need to be considered when arranging referral, and hence this section gives recommendations for discussing and consulting with specialist colleagues.

9.2.4 RECOMMENDATION

R72 The options for organising care for people with MDR TB should be discussed with clinicians who specialise in this. The views of the patient should be sought and taken into account, and shared care should be considered. D(GPP)

9.3 Infection control

9.3.1 Clinical introduction

Patients with sputum microscopy-positive MDR TB are no more infectious than similar patients with fully susceptible TB, ie they should not infect a higher proportion of contacts, because the organism is no more virulent. The

consequences of acquiring MDR TB infection and then disease, however, are much more serious than for fully susceptible TB, because MDR TB needs prolonged treatment (often with more toxic second-line drugs) and the outcome in terms of death and proportions cured are worse. Because of the loss of the most effective killing drug (isoniazid), and the most effective sterilising drug (rifampicin), such patients take much longer to become non-infectious than if organisms are fully susceptible (covered in section 6.5). In these cases there is not the rapid fall in numbers of viable organisms in the sputum seen in drug-susceptible cases, so they have a much prolonged infective potential after starting treatment.

Because of these differences it has been advised that patients with suspected or proven MDR TB should be isolated in a negative pressure room (as defined in recommendations below), and staff should wear FFP3 masks meeting the standards of the Health and Safety Executive{104} during patient contact whilst the patient is considered infectious.

The two major nosocomial outbreaks of MDR TB in the UK occurred because of failures in infection control procedures, either by carrying out risky procedures such as sputum induction in a communal HIV setting, or by isolating patients with active disease in a setting which had positive rather than negative pressure to the main ward.{232}

In 2005, the Chief Medical Officer's TB Action Plan{2} identified this as an essential area for improvement if trends for increasing incidence are to be reversed and better care provided for people with tuberculosis: 'Identify, facilitate access to, and ensure staff are aware of the appropriate isolation facilities and infection control precautions to be taken for patients with infectious, or potentially infectious TB, or who have drug resistant TB'. The recommendations provide the guidance the NHS needs to achieve this goal and prevent nosocomial infection.

9.3.2 Current practice

The review of current services collected the number of negative pressure units in service providers and aggregated these within HPU areas. There appears to be a positive relationship between the number of negative pressure units and number of notifications (see Figure 7).

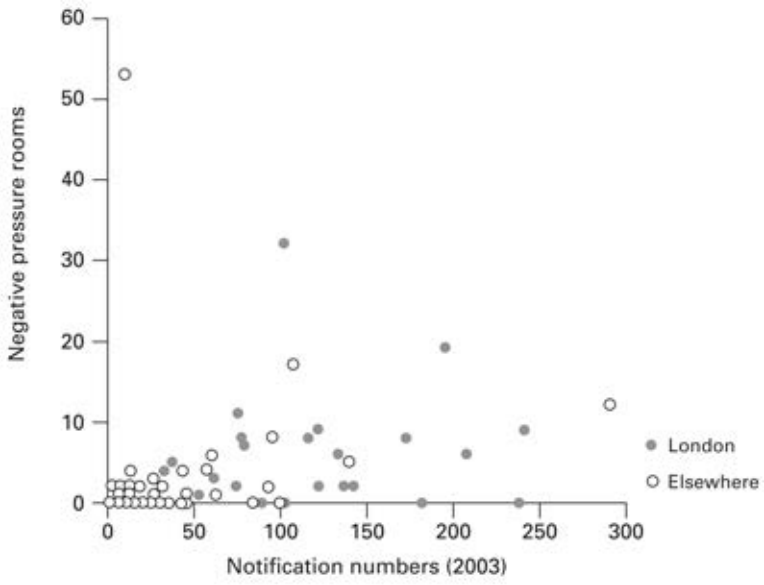


Figure 7 Negative pressure rooms vs. notified cases of TB per service provider

However, there seem to be errors in the reporting of the number of negative pressures units, which are much higher than expected, despite contacting the respondents to check. This discrepancy is too large to be accounted for by facilities being shared across HPU areas and counted twice, and so it seems that there is confusion among TB staff as to separate isolation rooms and negative pressure facilities. Given their use in cases of MDR TB, and the risk to other inpatients (with medicolegal implications), it would seem vital that staff working with TB are aware of the existing regulatory standards{105} regarding these facilities, and that it is made clear which isolation units meet these standards.

9.3.3 Methodological introduction

Studies were searched for which examined measures directed at patients with infectious suspected MDR TB to prevent transmission to other patients or contacts. (Measures to prevent transmission of TB to healthcare workers are addressed in chapter 13.)

Three retrospective cohort studies{233–235} were identified, all of which were performed in US hospitals after MDR TB outbreaks in wards of HIV-positive or AIDS patients. All hospitals introduced a range of infection control measures following the outbreaks.

2006

There are a number of methodological considerations with regard to all three studies. Firstly, as multifaceted infection control programmes were implemented over time, it is difficult to assess the contribution to outcome of each individual infection control measure. Secondly, the implementation of control measures was associated with a decrease in the number of case patients; the effectiveness of these control measures in the presence of a high concentration of infectious patients with MDR TB over a long time period could not be fully evaluated. Finally, each study involved only small numbers of MDR TB patients in one hospital and was completely reliant on the accuracy of patients' medical and laboratory records.

9.3.4 Evidence statements

Although approximately equal numbers of AIDS patients had same-ward exposures with MDR TB patients before and after the implementation of infection control measures (which were in accordance with Centers for Disease Control and Prevention recommendations), the MDR TB attack rate was significantly lower in the period after implementation (8.8% *vs.* 2.6%, p=0.01).{234} (**2+**)

The proportion of patients with MDR TB decreased in a period when infection control measures were introduced compared with the period before (14% compared with 32% of patients; RR 0.5, 95%CI 0.2 to 0.9, p=0.02). Patients diagnosed during the intervention period were less likely than those diagnosed during the pre-intervention period to have had an identified nosocomial exposure to another case patient during a previous hospitalisation (10% compared with 67% patients; RR 0.2, p=0.003).{233} (**2+**)

Exposure before implementation of improved infection control measures to an infectious MDR TB patient on the HIV ward was recorded in 80% of MDR TB patients and 45% of MDR TB patients post-implementation. After implementation of control measures, no episodes of MDR TB could be traced to contact with infectious MDR TB patients on the HIV ward.{235} (**2+**)

9.3.5 From evidence to recommendations

The evidence for infection control measures in patients with smear-positive TB suspected to be MDR is limited. This applies to both HIV-negative and HIV-positive cases. One limitation of the studies analysed was that they often introduced several

measures at once, so the effect of a single action was not determinable. Secondly, measures were compared before and after an outbreak, when there may have been better application of the pre-existing infection control measures after such an outbreak, as well as the introduction of new measures.

Although MDR TB is no more infectious than fully drug-susceptible TB, the consequences of acquiring MDR TB are much more serious because of the greater difficulty and costs of treating it, with prolonged infectivity and the risk of much poorer outcomes. Immunosuppressed patients (particularly those HIV infected) are much more likely to acquire TB infection, and to progress to clinical disease.

The recommendations reinforce the essential role of negative pressure facilities in providing MDR TB care, based on a continuation of the practices previously recommended by the BTS.{6}

9.3.6 RECOMMENDATIONS

R73 Patients with suspected or known infectious MDR TB who are admitted to hospital should be admitted to a negative-pressure room. If none is available locally, the patient should be transferred to a hospital that has these facilities and a clinician experienced in managing complex drug-resistant cases. Care should be carried out in the negative-pressure room until the patient is found to be non-infectious or non-resistant, and ideally until cultures are negative. D(GPP)

R74 Staff and visitors should wear FFP3 masks,[13] during contact with a patient with suspected or known MDR TB while the patient is considered infectious. D(GPP)

R75 Before the decision is made to discharge a patient with suspected or known MDR TB from hospital, secure arrangements for the supervision and administration of all anti-TB therapy should have been agreed with the patient and carers. D(GPP)

R76 The decision to discharge a patient with suspected or known MDR TB should be discussed with the infection control team, the local microbiologist, the local TB service, and the consultant in communicable disease control. D(GPP)

[13] European standard EN149:2001; masks should meet the standards in 'Respiratory protective equipment at work: a practical guide HSG53' published by the Health and Safety Executive (2005). Available from www.hse.gov.uk

R77 Negative pressure rooms used for infection control in MDR TB should meet the standards of the Interdepartmental Working Group on Tuberculosis,{386} and should be clearly identified for staff, for example by a standard sign. Such labelling should be kept up to date. D(GPP)

Cross-referring:

For details of contact tracing in hospital in-patients, see section 12.7. Also see the algorithm in section 6.2.

9.4 Treatment of non-MDR TB resistance

9.4.1 Clinical introduction

This guideline concentrated on the evidence base for MDR TB through a systematic literature search and critical appraisal, but for completeness this subsection addresses the other forms of drug resistance. The GDG, having examined the evidence base for MDR TB, were in agreement that the guideline should reflect the guidance given by the BTS in 1998.{68} Treatment of patients with drug-resistant tuberculosis is carried out only by specialist physicians with appropriate experience in managing such cases.

Isolated streptomycin resistance

The recommended standard regimen for fully susceptible TB (see chapters 6 and 7) is unaffected.

Isolated isoniazid resistance

If this resistance is known before treatment commences, a regimen of rifampicin, pyrazinamide, ethambutol and streptomycin for two months followed by rifampicin and ethambutol for a further seven months gives good results by DOT.

If this resistance is found after treatment has been started, isoniazid may be stopped. Ethambutol, pyrazinamide and rifampicin should be given for two months followed by ethambutol and rifampicin for a further 10 months.

Isolated pyrazinamide resistance

Pyrazinamide resistance is usually due to infection by *M. bovis*. Ethambutol, isoniazid and rifampicin should be given for two months followed by isoniazid and

rifampicin for a further seven months. Isolated pyrazinamide resistance in *M. tuberculosis* infection should be treated with the same regimen.

Isolated ethambutol resistance

Isolated ethambutol resistance is uncommon. Isoniazid, pyrazinamide and rifampicin should be given for two months followed by isoniazid and rifampicin for a further four months.

Isolated rifampicin resistance

If rifampicin resistance is detected by either genetic probe or drug susceptibility testing, the patient should be isolated (see Fig 10) and treated as MDR TB until a full drug susceptibility profile of first-line drugs is available. Isolated rifampicin resistance is very uncommon but does occur and requires modification and extension of treatment to a period of 18 months, that is ethambutol, isoniazid and pyrazinamide for two months followed by isoniazid and ethambutol for a further 16 months. In approximately 90% of cases however, rifampicin resistance is not isolated and is a genetic marker for MDR TB.

Combined streptomycin and isoniazid resistance

This is the commonest dual resistance. This should be treated with the regimen for isolated isoniazid resistance found during treatment (see above).

Other non-MDR TB combinations

These are uncommon. Treatment would need to be individualised depending on the combination involved, and is best determined after discussion with a highly experienced clinician and the HPA Mycobacterium Reference Units.

9.4.2 RECOMMENDATION

R78 Patients with drug-resistant TB, other than MDR, should be under the care of a specialist physician with appropriate experience in managing such cases. First-choice drug treatment is set out in Table 31.

Table 31 Recommended drug regimens for non-MDR drug-resistant TB

Drug resistance	Initial phase	Continuation phase
S	2RHZE	4RH
H known before to treatment	2RZSE	7RE
H found after starting treatment	2RZE	10RE
Z	2RHE	7RH

E	2RHZ	4RH
R (only if confirmed isolated resistance)	2HZE	16HE
S+H	2RZE	10RE
Other	Individualised	
See Appendix D for details of the system of drug regimen abbreviations		

10 Management of latent tuberculosis

10.1 Treatment regimens for latent tuberculosis infection

10.1.1 Clinical introduction

Latent TB is defined in this guideline as infection with mycobacteria of the *M. tuberculosis* complex, where the bacteria are alive but not currently causing active disease. In people with latent TB, the rationale for treating those identified as infected by either Mantoux or IGTs is to kill any residual dormant bacilli in order to reduce or prevent later reactivation of tuberculosis disease. Single-agent isoniazid has been used in this role for at least 35 years, with considerable data on its efficacy in regimens of between six and 12 months.

In 2005, the Chief Medical Officer's TB Action Plan{2} set a goal of advising 'on the management of patients requiring preventive chemoprophylaxis according to national (currently British Thoracic Society) guidelines'. These guidelines should provide such advice, with an updated review of evidence in this field for clinicians in England and Wales.

10.1.2 Current practice

The review of current services found that the number of cases receiving treatment for latent TB infection correlated with neither the number of contacts nor new entrants screened. These data were aggregated across HPU localities to account for the different functions performed by different service providers. It would seem that different practices in contact tracing and new entrant screening have different yields in detecting or treating latent TB.

2006

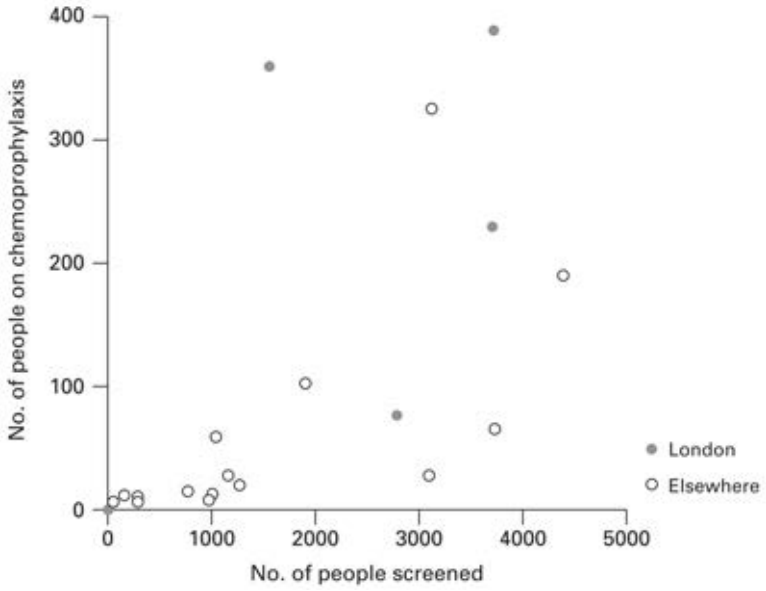


Figure 8Correlation of people screened against people given treatment for latent TB infection (chemoprophylaxis)

10.1.3 Methodological introduction

A detailed Cochrane review{236} looked at randomised trials of isoniazid of at least six months duration which were placebo controlled with at least two years follow-up, but excluded patients with known HIV infection. This review (11 trials totalling 73,375 patients) showed that durations of isoniazid of longer than six months had no additional benefit over that of six months (RR of 0.44, 95% CI 0.27 to 0.73 for six month, and 0.38, 95% CI 0.28 to 0.50 for 12 months). The toxicity of isoniazid was 0.26% of people on six months treatment and 0.52% of people treated for 12 months. Consideration of regimens for treatment of latent TB infection in this guideline was limited to those of six months' duration or shorter.

Two RCTs in adults with latent TB compared regimens of six months of prophylactic drug treatment with regimens of lesser duration in the prevention of the development of active TB. One study{237} compared rifampin given for three months, isoniazid and rifampin given for three months, isoniazid given for six months and placebo, in Chinese men with silicosis and Mantoux test results of greater than or equal to 10 mm of induration. The other study{238} compared isoniazid given for either three months or six months with placebo in tuberculin-positive participants with fibrotic lesions in seven European countries.

2006

Several other studies compared regimens of six months of prophylactic treatment with isoniazid with two months of treatment with pyrazinamide and rifampin.{239–241} However, these studies were excluded as outcomes reported were adverse events and treatment completion rates and not the number of active TB cases which developed during follow-up.

Two studies in children were found. One RCT compared groups of tuberculin positive 5–15-year-olds in India who either did not receive prophylaxis, or received isoniazid for three months, rifampicin and isoniazid for one month, rifampicin and isoniazid for three months or isoniazid, rifampicin and pyrazinamide for one month.{242} This study however, was excluded due to methodological limitations. The only other study found in children was an observational study which described the use of various durations of isoniazid and rifampicin over a 15-year period in a UK health district and looked at active TB notification rates during this period.{243}

Three systematic reviews examined prophylaxis for TB in individuals with HIV infection.{244–246} The most recent of these reviews was a Cochrane review{246} which looked at preventive treatment for TB in comparison with placebo and additionally included studies which compared different regimens of preventive treatment (ie no placebo comparison). It included eleven trials with a total of 8,130 participants. This review replaced a previous Cochrane review.{247} The authors of the previous Cochrane review additionally published a systematic review of preventive treatment in HIV-infected individuals which included only studies which compared preventive treatment with placebo.{245} This study has been excluded as the four trials it included, plus several more, are all included in the updated Cochrane review {246} and in another systematic review published in 1999.{244} The 1999 systematic review{244} of isoniazid prophylaxis treatment compared with placebo has also been excluded to avoid double counting of trials as all of the studies it included (except two which have only been published as abstracts) are in the Cochrane review.{246}

The case definition of TB used varies across studies as does the proportion of cases with culture verification.

2006

10.1.4 Evidence statements

Efficacy

In a European study{238} of tuberculin-positive participants with fibrotic lesions in seven European countries, the risk of active TB was reduced by 21% by 12 weeks of isoniazid and 65% by 24 weeks when compared with placebo. The difference between the 12-week regimen and placebo was not statistically significant but the difference between the 12-week and the 24-week regimen was ($p<0.05$). (**1++**)

In a study in Hong Kong{237} of Chinese men with silicosis, the cumulative percentage of patients with active pulmonary TB over five years was compared in the patients who had received their prophylactic treatment without interruption. This percentage was higher in the placebo series than in the three treatment of latent TB infection groups combined ($p<0.01$) but there was no evidence of significant differences between the three treatment of latent TB infection regimens (placebo=27%, isoniazid and rifampin for three months=16%, isoniazid for six months=14% and rifampin for three months=10%). When the patients with extrapulmonary TB and those whose regimen was interrupted were included, the estimated rates at five years were 27% in the placebo series and 17% in the three treatment of latent TB infection series combined ($p<0.05$). (**1+**)

Treatment completion

In the European study{238} in the 12-week treatment groups, 87% completed isoniazid treatment and 91% placebo. These percentages were 78% and 82% respectively for the 24-week groups. (**1++**)

In the Hong Kong study,{237} 86% of participants in the three-month rifampin group, 76% in the isoniazid and rifampin three-month group, 74% in the six-month isoniazid group and 84% in the placebo group completed their allocated regimen without known interruption. (**1+**)

Adverse events

In the European study{238} the excess risk of hepatitis per 1,000 persons of isoniazid over placebo was 2.5 in the first 12 weeks and 1.1 in weeks 13–24. The number of hepatitis cases which could be avoided by shortening the duration of isoniazid from 24 weeks to 12 weeks would be 1.1 per 1,000 persons. (**1++**)

2006

In the Hong Kong study{237} adverse effects were reported with a similar frequency in all four groups in the first 12 weeks. During this time, hepatic toxicity was reported in eight (1%) patients (three in the three-month isoniazid and rifampin group, three in the six-month isoniazid group and two in the placebo group) with only one (in the six-month isoniazid group) having symptomatic hepatitis. Only 4% of patients had their regimen stopped because of reactions. The serum alanine aminotransferase concentrations were higher in the three month isoniazid and rifampin and six month isoniazid series than in the three-month rifampin series ($p<0.001$) but there was no significant difference between the three-month rifampin series and placebo. (**1+**)

Children

In a study conducted in one health district in the UK{243} of children on treatment for latent TB infection, no child notified with TB in the period 1987–1996 (when shorter four month and three month regimens were introduced) had received treatment for latent TB infection previously. Furthermore, no child on treatment for latent TB infection required their three or four month regimen of isoniazid and rifampicin treatment to be stopped for possible side effects during the nine year period since the introduction of these regimens. (**3**)

People with HIV: development of active TB

A Cochrane systematic review{246} found that preventive therapy (any anti-TB drug) *vs.* placebo was associated with a lower incidence of active TB (RR 0.64, 95%CI 0.51 to 0.81). All drug regimens regardless of type, frequency or duration of treatment, reduced the incidence of active TB compared with placebo and no differences were found between active regimens in terms of effectiveness. (**1++**)

The review{246} found that among individuals who were tuberculin skin test positive, preventive therapy reduced the risk of active TB by 62% (RR 0.38, 95%CI 0.25 to 0.57). Although a similar trend was found for individuals with a negative tuberculin test these results were not statistically significant. (**1++**)

People with HIV: all-cause mortality

The review{246} found no evidence that preventive therapy versus placebo reduced all-cause mortality. (**1++**)

People with HIV: incidence of adverse drug reactions

Compared to placebo, preventive therapy led to more adverse events resulting in stopping treatment (RR 2.49, 95%CI 1.64 to 3.77). The likelihood of stopping treatment due to adverse effects was higher for combination therapies than for isoniazid monotherapy compared with placebo (eg for isoniazid *vs*. placebo: RR 1.66, 95%CI 1.09 to 2.51 whilst for isoniazid and rifampicin *vs*. placebo: RR 16.72, 95%CI 3.29 to 84.9).{246} (**1++**)

10.1.5 From evidence to recommendations

A European study{238} found six months isoniazid to be more effective than three months whilst a Hong Kong study{237} found no difference in effectiveness between isoniazid and rifampin for three months (3RH) and isoniazid for six months (6H) in those who were not HIV positive. Therefore, either 6H or 3RH could be used.

The Hong Kong study also demonstrated no difference between these two regimens and three months of rifampicin. In the UK, six months of rifampicin has been demonstrated to be effective, and the GDG recommended a six-month course to avoid any risk of rifampicin-resistant strains developing.

In 2000 a regimen of rifampicin and pyrazinamide for two months (2RZ) was recommended for treatment for latent TB infection in the USA.{248} In the UK, although this 2RZ regimen was felt to have equivalent efficacy to a regimen of three months rifampicin and isoniazid (3RH), because it was predicted to have significantly higher toxicity, the 2RZ regimen was not recommended for use in the UK.{68} Subsequent experience in clinical practice in the USA confirmed significant hepatotoxicity, including deaths, in clinical practice,{249–251} which led in 2003 to the American Thoracic Society and the Centers for Disease Control advising that this regimen no longer be routinely used for treatment for latent TB infection.{250}

There was no high-level evidence in neonates or children, so recommendations are based on clinical experience. The recommendations shown below were drawn up to reflect the group consensus.

A Cochrane review{246} in HIV-positive people found in those who were tuberculin positive, preventive therapy reduced the risk of active TB. A similar but non-

significant trend was found for individuals with a negative Mantoux test. The likelihood of stopping treatment due to adverse effects was higher for combination therapies than for isoniazid monotherapy, therefore the latter has been recommended in this population.

People should be selected for treatment for latent TB infection by the risk factors set out in section 10.1. Risk of hepatotoxicity from these drugs increases with age. Although there was no evidence to recommend an age threshold, it has been common practice in the UK not to advise treatment for latent TB infection for otherwise eligible people who are over the age of 35, as the risk may start to outweigh the potential benefit.

All the recommendations identify people on the basis of the two-step testing process for latent TB which is recommended in section 5.1. Obvious exceptions will occur when, for example, the patient is immunocompromised and Mantoux test is not reliable, and clinical judgement will be required.

The recommendations state that treatment for latent TB infection with 3RH or 6H regimens would be ineffective in contacts of people with MDR TB. In these and other cases where treatment for latent TB infection is not recommended, 'inform and advise' information is needed. Follow-up is also recommended for contacts of a person with MDR TB.

2006

10.1.6 RECOMMENDATIONS

2006, amended 2011

R79 Treatment of latent TB infection should be considered for people in the following groups, once active TB has been excluded by chest X-ray and examination: D(GPP)

- people identified through screening who are:
  - 35 years or younger (because of increasing risk of hepatotoxicity with age[14])
  - any age with HIV
  - any age and a healthcare worker

and are either:

- Mantoux positive (6 mm or greater), and without prior BCG vaccination, *or*

[14] For people aged 36 or older, consider risks and benefits for the individual before offering treatment.

– strongly Mantoux positive (15 mm or greater), interferon-gamma positive, and with prior BCG vaccination

- children aged 1–15 years identified through opportunistic screening, to be:
  – strongly Mantoux positive (15 mm or greater), *and*
  – interferon-gamma positive (if this test has been performed), *and*
  – without prior BCG vaccination
- people with evidence of TB scars on chest X-ray, and without a history of adequate treatment.

2006, amended 2011

R80 People with HIV who are in close contact[15] with people with sputum smear-positive respiratory TB should have active disease excluded and then be given treatment for latent TB infection (see R10-13).

R81 Treatment for latent TB infection should not be started in close contacts of people with sputum smear-positive MDR TB who are strongly Mantoux positive (15 mm or greater), as no regimen is of proven benefit, and only a small proportion of people infected will develop the disease. Long-term monitoring should be undertaken for active disease. D(GPP)

R82 People who have agreed to receive treatment for latent TB infection should be started on one of the following regimens: C

- either six months of isoniazid (6H) or three months of rifampicin and isoniazid (3RH) for people aged 16–35 not known to have HIV A
- either six months of isoniazid (6H) or three months of rifampicin and isoniazid (3RH) for people older than 35 in whom treatment for latent TB infection is recommended (see R62) and who are not known to have HIV D(GPP)
- six months of isoniazid (6H) for people of any age who have HIV A
- six months of rifampicin (6R) for contacts, aged 35 or younger, of people with isoniazid-resistant TB. D(GPP)

2006

[15] Close contacts may include a boyfriend or girlfriend and frequent visitors to the home of the index case, in addition to household contacts.

People eligible for treatment of latent TB infection, but who decline to take this treatment, should be given 'inform and advise' information about TB and have chest X-rays three and 12 months later. D(GPP)

2006

R83 Neonates who have been in close contact with people with sputum smear-positive TB who have not received at least two weeks' anti-tuberculosis drug treatment should be treated as follows. D(GPP)

- The baby should be started on isoniazid (refer to the current ‘British national formulary for children’) for three months and then a Mantoux test performed after three months' treatment.
- If the Mantoux test is positive (6 mm or greater) the baby should be assessed for active TB (see section 5.2). If this assessment is negative, then isoniazid should be continued for a total of six months.
- If the Mantoux test is negative (less than 6 mm), it should be repeated together with an interferon-gamma test. If both are negative then isoniazid should be stopped and a BCG vaccination be performed (see chapter 11).

R84 Children older than four weeks but younger than two years who have not had BCG vaccination and are in close contact with people with sputum smear-positive TB should be treated as follows. D(GPP)

- The child should be started on isoniazid (refer to the current ‘British national formulary for children’) and a Mantoux test performed.
- If the Mantoux test is positive (6 mm or greater), the child should be assessed for active TB (see section 5.2). If active TB is ruled out, full treatment for latent TB infection should be given (see R86).
- If the Mantoux test is negative (less than 6 mm), then isoniazid should be continued for six weeks, and then a repeat Mantoux test together with an IGT test should be carried out.
- If the repeat tests are negative, isoniazid may be stopped and BCG vaccination performed (see chapter 11).

2006, amended 2011

- If either repeat test is positive (6 mm or greater), then the child should be assessed for active TB (see section 5.2.) and consider treating for latent TB. Contact tracing for children younger than two years when the index case is sputum-smear-positive is summarised in an algorithm (section 12.2).

R85 BCG-vaccinated children aged older than four weeks but younger than two years, in close contact with people with sputum-smear-positive respiratory TB, should be treated as follows. D(GPP)

- The child should have a Mantoux test. If this is positive (15 mm or greater), the child should be assessed for active TB (see section 5.2). If active TB is excluded, then treatment for latent TB infection should be given (see R86).
- If the result of the test is as expected for prior BCG (less than 15 mm), it should be repeated after six weeks together with an interferon-gamma test.
- If the repeat Mantoux test is also less than 15 mm, and the interferon-gamma test is also negative, no further action is needed.
- If the repeat Mantoux test becomes more strongly positive (15 mm or greater and an increase of 5 mm or more over the previous test), or the interferon-gamma test is positive the child should be assessed for active TB (see section 5.2). If active TB is excluded, treatment for latent TB infection should be given.

R86 For children requiring treatment for latent TB infection, a regimen of either three months of rifampicin and isoniazid (3RH) or six months of isoniazid (6H) should be planned and started, unless the child is known to be HIV positive, when 6H should be given (see R82). D(GPP)

R87 Healthcare workers should be aware that certain groups of people with latent TB are at increased risk of going on to develop active TB, including people who: D(GPP)

- are HIV positive
- are injecting drug users
- have had solid organ transplantation

2006, amended 2011

2006

- have a haematological malignancy
- have had a jejunoileal bypass
- have chronic renal failure or receive haemodialysis
- have had a gastrectomy
- are receiving anti-tumour necrosis factor (TNF)-alpha treatment
- have silicosis.

Patients in these groups should be advised of the risks and symptoms of TB, on the basis of an individual risk assessment basis, usually in a standard letter of the type referred to as 'inform and advise' information.

Cross-referring:

For details of excluding active TB, see section 5.2.

For details of DOT, see section 8.2.

For details of approaches to improving adherence, see section 8.3.

For details of active case finding, including contact tracing, see chapter 12.

For examples of 'inform and advise' information, see Appendix H.

10.2 Risk factors for tuberculosis infection: selecting people for treatment for latent tuberculosis infection

10.2.1 Clinical introduction

The risk of developing clinical TB depends on both the risk of becoming infected, and the risk that after acquiring infection this will progress to disease. This section addresses the latter risk.

Further considerations are the age at which initial infection occurs and time since initial infection. Infection earlier in life, particularly under age five, may be associated with increased risks of progression and dissemination of disease. The greatest chance of progressing to disease is within the first two years after infection, with half of all cases of disease occurring within five years of the original infection.{252} There however remains a lifelong risk of progression to disease for all those with 'dormant' organisms. Such people are a minority of infected patients. International data shows,{253} that whilst some 32% of the world's population (1.9 billion) was estimated infected as judged by a positive Mantoux test, only some 8–11 million persons per year are estimated to develop clinical disease.

Many more studies exist which examine the risk factors for active tuberculosis in groups irrespective of tuberculin skin test status. These studies do not show whether such groups are more likely to develop latent infection, or if infected progress to clinical disease, or whether both mechanisms apply.

Treatment for latent TB infection can be either secondary, after latent infection has occurred (see section 10.1), or primary to try to prevent the acquisition of infection after exposure. Most studies concentrate on secondary treatment for latent TB infection, but there are circumstances where primary treatment for latent TB infection may be appropriate, for example exposure of neonates to sputum smear-positive parents, or of people with HIV to people with sputum smear-positive TB.

10.2.2 Current practice

The Health Protection Agency's systems of notification and enhanced surveillance (see chapter 14 for details) do not collect data on cases of latent tuberculosis, or on people screened and found to be uninfected.

The review of current services followed-up respondents reporting more than five people screened for latent tuberculosis in 2003, and sought a breakdown between those who were new entrants and those who were contacts of people with infectious TB. Although all the clinics that were followed-up were able to provide some response, in the majority they reported that they could not derive such detail from the data that they had collected locally. Many reported ongoing work to improve their local collection of data on screening.

10.2.3 Methodological introduction

The evidence was examined to consider which TB-infected population groups are the most likely to progress from infection to active TB. This information identifies those who would benefit most from treatment for latent TB infection.

Few studies considered the risk of developing active TB in those known to have (or highly likely to have) latent infection, probably because these groups are likely to receive treatment for latent TB infection (except in older studies). Furthermore, these studies do not in general have a tuberculin-positive control group without the risk factor, so it is not possible to calculate relative risks, only incidence rates.

Additionally, the consideration of HIV infection as a risk factor for active TB in those with latent infection is problematic. This is due to the difficulties of diagnosing latent tuberculosis in this population using conventional skin test methods.

Many more studies exist which examine the risk factors for active TB in groups irrespective of Mantoux test status. It is unclear, however, whether these groups are more likely to develop latent tuberculosis or once they had infection, are at a higher risk of progressing to active TB, both of which could be explanations for these groups having a high rate of active TB compared to control groups.

10.2.4 From evidence to recommendations

The GDG discussed the issues and agreed that, rather than attempting to synthesise all the evidence in this area, it would be more useful to provide tables of risk factor data. These tables, modified from the American Thoracic Society official statement of 'targeted tuberculin testing and treatment of latent infection'{248} are shown below. Table 32 ranks a range of active TB incidence rates in tuberculin-positive persons with certain risk factors/medical conditions. Table 33 (overleaf) ranks a range of relative risks of active tuberculosis, in populations with certain risk/factors/medical conditions, independent of Mantoux test status.

While people who are underweight and/or have diabetes are at increased relative risk of TB, the GDG did not feel that it would be appropriate to alert them all to the symptoms and signs of TB as their absolute risks of TB are very low.

10.2.5 RECOMMENDATIONS

The evidence supporting this section informed the recommendations given in section 10.1.

Table 32: Incidence of active TB in persons with a positive tuberculin test by selected risk factors

Risk factor		**TB cases/1,000 person-years**
HIV infection{254}		35.0–162
Injecting drug use{255}	HIV seropositive	76.0
	HIV seronegative or unknown	10.0
Silicosis{237}		68.0
Recent latent tuberculosis{256}	Infection <1 year past	12.9

	Infection 1–7 years past	1.6
Radiographic findings consistent with prior TB{257–259}		2.0–13.6
Weight deviation from standard{260}	Underweight by >15%	2.6
	Underweight by 10–14%	2.0
	Underweight by 5–9%	2.2
	Weight within 5% of standard	1.1
	Overweight by >5%	0.7

2006

Table 33: Relative risk for developing active TB by selected clinical conditions

Clinical condition		**Relative risk**
Solid organ transplantation	Renal{261}	37
	Cardiac{262},{263}	20–74
Jejuno-ileal bypass{264},{265}		27–63
Silicosis{266}		30
Chronic renal failure/haemodialysis{267–269}		10–25.3
Gastrectomy{270–272}		2.5
Diabetes mellitus{273–275}		2.0–41
Anti-TNF-alfa treatment{276},{277}		4–8
Contact smear-positive TB{278}		5–10

11 BCG vaccination

11.1 Overview

11.1.1 Overall introduction

Bacille Calmette-Guerin (BCG) was developed by Calmette and Guèrin, at the Pasteur Institute (Lille) using *in vitro* attenuation by repeated passage of an isolate of *M. bovis* from 1908 onwards; it was finally tested in humans in 1921. Since BCG has never been cloned and has been grown under different conditions and in different laboratories, genetic differences have developed between the various commercially used strains,{279} so called 'antigenic drift'. Genome research has since shown that in the passaging of the organism, but before its distribution from the Pasteur Institute, a section of the genome, the RD1 region, was deleted. This deleted region common to all BCG strains contains antigens such as ESAT6, CFP10 and tb7.7 which are now used in interferon-gamma based blood tests, and hence these blood tests are not affected by prior BCG vaccination (see section 5.1 for further details).

The efficacy of a vaccine is a measure of its activity on individuals given the vaccine and can be defined as the proportion of those vaccinated who gain protective immunity from the vaccination.{280} Huge variations in estimates of efficacy against pulmonary TB, ranging from 0% to >80%, have been shown for different BCG vaccines in various geographical settings.

While a number of explanations have been put forward for this, geographical latitude seems to have a particularly important effect, accounting for over 40% of the variability in efficacy.{281} Thus nearly zero efficacy against tuberculosis in India,{282} is contrasted with a 64% protective efficacy in people of Indian origin with the same vaccine in a higher, more temperate, latitude.{283} Though the effect of climate on environmental mycobacteria has been suggested as the cause of the latitude effect, this has not been proven.

A further conundrum in BCG efficacy is that even in parts of the world where there is little reported efficacy against tuberculosis, efficacies of 50–60% are reported against leprosy and Buruli ulcer, caused by other mycobacteria.{280} Yet another problem with interpreting the data is that although it was assumed that the tuberculin sensitivity induced by BCG vaccination correlated with protective efficacy, this is not so. In a large UK study there was no correlation between tuberculin sensitivity induced by BCG and protective efficacy; those individuals tuberculin negative after BCG vaccination derived just as much protection as those who became tuberculin positive.{284}

Many controlled trials have followed efficacy for 10–15 years and have shown some decline over time, but the total duration of any benefit was not known and could only be expressed as an efficacy lasting up to 15 years.{285} The only truly long-term follow-up of BCG vaccination, in a North American aboriginal population, reported in 2004, showed 50% protective efficacy lasting for at least 50 years.{286}

BCG is a live vaccine and as such is contraindicated{3} in a number of situations where the immune system may be compromised, particularly if the person is known or suspected to be HIV positive, because of the risk of generalised BCG infection. HIV testing, after appropriate counselling, is also an important consideration, but lies outside the scope of this guideline. Readers should be aware of the British HIV Association guidelines on TB/HIV co-infection{8} and those forthcoming on testing from the British Association for Sexual Health and HIV.

Current practice in vaccination is led by the advice of the Joint Committee on Vaccination and Immunisation, principally through the 'Green Book'.{3},{21}

11.1.2 OVERALL RECOMMENDATIONS

R88 When BCG is being recommended, the benefits and risks of vaccination and remaining unvaccinated should be discussed with the person (or, if a child, with the parents), so that they can make an informed decision. This discussion should be tailored to the person, be in an appropriate language, and take into account cultural sensitivities and stigma. D(GPP)

R89 People identified for BCG vaccination through occupational health, contact tracing or new entrant screening who are also considered to be at increased risk of

being HIV positive, should be offered HIV testing before BCG vaccination[16]. (See section 10.1 for details of further action in HIV-positive patients.) D(GPP)

11.2 For neonates

11.2.1 Clinical introduction

Neonatal BCG (up to age three months) is given in countries, or in subgroups defined by ethnicity and/or deprivation, with high rates of TB disease. Efficacy studies on neonatal BCG have used different end points which have contributed to some confusion about its efficacy in various settings. These have included the end points of pulmonary disease, death, TB meningitis, disseminated (miliary) disease, and laboratory-confirmed cases.

In England and Wales, which has had a selective neonatal BCG programme for over 20 years, assessments of coverage of appropriate infants have shown substantial variation in, and deficiencies in, both BCG policy and implementation.{287} These deficiencies and system problems were particularly in medium and low TB incidence districts which often had no system for identifying those neonates for whom BCG was recommended.

11.2.2 Current practice

The DH advises BCG vaccination for all neonates at higher risk of TB, with opportunistic vaccination of older children as necessary, according to criteria set out below in the recommendations.

The review of current services, conducted in the year prior to the introduction of neonatal vaccination and abolition of school-based vaccination, found that outside London, only two of 62 clinics (3%) (in the same HPU, an area of high notifications) reported universal neonatal BCG vaccination. In London, 12 of 31 clinics (39%) reported universal coverage. There was no consistency in the risk groups used for selected neonatal BCG. Many respondents did not name any explicit risk groups, but those who gave details mostly cited ethnicity, immigration and family history as the means for identifying neonates at higher risk.

2006

[16] See the British HIV Association guideline for details of further action in HIV-positive patients. Available from www.bhiva.org.

11.2.3 Methodological introduction

Studies investigating the effectiveness of BCG vaccination administered in neonates and infants in preventing the development of TB infection or disease were sought. This was compared to unvaccinated groups in relevant populations. One meta-analysis, one cohort study and one case control study were found.

One meta-analysis conducted in the USA{288} included five RCTs and 11 case control studies in the analysis. The scope was international, but all RCTs were conducted in the northern hemisphere and were situated far from the equator relative to case controls, which were distributed across both temperate and equatorial regions. The analysis combined RCT and case control studies separately and did not use cross-design analysis since there were too few RCTs relative to case control studies. It was therefore appropriate to grade the evidence statements according to whether they were derived from the RCT (level 1) or case control results (level 2).

Factors for consideration raised by the meta-analysis included the following:

- The duration of BCG vaccination protection administered in infancy was inadequately established despite information on this issue being available from six studies. This was due to the small numbers of TB cases when data was analysed separately by year of occurrence.
- The impact of BCG strain on efficacy of immunisation was not associated with variation in the protection afforded by the vaccine in the studies reviewed.
- Differences in the characteristics and methodological quality of individual studies were addressed by a sensitivity analysis, expressed as a study quality validity score.
- Study quality validity scores accounted for 15.3% of the heterogeneity in the results of the nine case control studies, while RCTs were homogeneous.
- Distance from the equator did not appear to be an important correlate of BCG efficacy reported by case control studies, while RCTs displayed homogeneity in terms of distance from the equator.

One cohort study conducted jointly in the Federal Republic of Germany (FRG) and the German Democratic Republic (GDR),{289} was published prior to the meta-analysis, but not cited in it. The study retrospectively focused on BCG vaccination

administered to an entire population of neonates in the GDR over a three and a half year period compared to no vaccination in the FRG over the same time period to investigate the efficacy of the vaccine in preventing cases of TB meningitis.

A case control study conducted in Spain,{290} which was not cited in the meta-analysis was excluded due to methodological limitations presented in Appendix I.

11.2.4 Evidence statements

Evidence was found for the efficacy of BCG vaccination in infancy for preventing:

- pulmonary TB disease
- TB deaths
- TB meningitis
- laboratory-confirmed TB cases
- disseminated TB.

Evidence for these five outcomes is presented in Table 34.

Table 34: Summary of evidence: neonatal BCG vaccination

Outcomes	Intervention: BCG vaccinated *vs.* unvaccinated infants	Results	Association/statistical significance	Ref and NICE grade
Pulmonary TB disease	Four RCTs	Protective effect 0.74	Combined RR 0.26 (95% CI 0.17 to 0.38, p< 0.05)	{288} 1+
	Nine case control studies	Protective effect 0.52	Combined OR 0.48 (95% CI 0.37 to 0.62, p<0.05)	{288} 2+
TB deaths	Five RCTs	Protective effect 0.65	Combined RR 0.35 (95% CI 0.14 to 0.88, p<0.05)	{288} 1+
TB meningitis	Five case control studies	Protective effect 0.64 (based on 181 cases of TB meningitis)	Combined OR 0.36 (95% CI 0.18 to 0.70, p<0.05)	{288} 2+
	One cohort study	0/770,000 intervention *vs.* 57/2,100,000 (0.0048%) control cases developed TB disease	Not reported	{289} 2+
Laboratory-confirmed TB	Three case control studies	Protective effect 0.83 (based on	Combined OR 0.17 (95% CI 0.07 to 0.42,	{288} 2+

2006

cases		results of 108 TB cases confirmed by either histology or culture)	p<0.05)	
Disseminated TB	Three case control studies	Protective effect 0.78	Combined 0.22 (95% CI 0.12 to 0.42, p<0.05)	{288} 2+

11.2.5 Health economics

The GDG considered the interactions between neonatal and school-age BCG vaccination programmes required population dynamic economic modelling, which is, at the time of writing, being commissioned by the DH. With this in mind, recommendations on neonatal BCG are presented purely on the basis of clinical evidence, pending the findings of the model.

11.2.6 From evidence to recommendations

Neonatal BCG is significantly better than no vaccine using the end points of pulmonary disease, death, meningitis, laboratory-confirmed TB and disseminated TB.

There is difficulty ensuring thorough vaccination coverage in primary care, where babies are not registered until the first appointment, compared to vaccination by midwives, for example, where coverage can be assured.

The GDG supported the explicit criteria set out by the WHO for discontinuing universal vaccination, but wished TB clinicians and service planners to be aware of possible future changes to the criteria in response to changing global epidemiology. The aim of this section is to guide clinicians in vaccinating those who are most at risk.

Given the conclusions of the health economics for school-based BCG vaccination in section 11.3, the recommendations seek to provide guidance for a neonatal BCG programme that will offer protection to all who are at risk. In a high-incidence area, this may be most easily provided by a universal programme.

The largest group of neonates who are at increased risk of TB are those whose families have immigrated from high-incidence countries. Neonates continue to be at risk even if their parents were also UK born because of continuing migration, home visits and exposure to increased levels of TB within communities. The

recommendations therefore advise selection on the basis of a parent or a grandparent being born in a high-incidence country. GDG members were aware of selection being practised on the basis of skin colour or surname, and aimed to provide clear-cut recommendations to replace these practices.

In accordance with the Green Book,{3} tuberculin skin testing is not routinely recommended prior to BCG vaccination for children under six years of age.

11.2.7 RECOMMENDATIONS

R90 Neonatal BCG vaccination for any baby at increased risk of TB should be discussed with the parents or legal guardian. D(GPP)

R91 Primary care organisations with a high incidence of TB[17] should consider vaccinating all neonates soon after birth. D(GPP)

R92 In areas with a low incidence of TB[17], primary care organisations should offer BCG vaccination to selected neonates who: D(GPP)

- were born in an area with a high incidence of TB[17],~~[17]~~ or
- have one or more parents or grandparents who were born in a high-incidence country,[18] or
- have a family history of TB in the past five years.

R93 Mantoux testing should not be done routinely before BCG vaccination in children younger than six years. D(GPP)

Cross-referring:

For details of identifying the Mycobacterium species prior to large-scale contact tracing, see section 5.3

11.3 For infants and older children

11.3.1 Clinical introduction

Following clinical trials in the early 1950s, BCG vaccination was introduced for previously unvaccinated adolescents aged 10–14.{284} Age 10–14 was selected for vaccination in 1953 because at that time, in what was nearly entirely a white UK-

2006

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[17] As defined by the HPA; go to www.hpa.org.uk and search for 'tuberculosis rate bands'.
[18] Go to www.hpa.org.uk and search for 'WHO country data TB'.

born population, TB was most common in those aged 15–29 (with a second peak in older people). This cohort, now aged over 70, have the highest TB rates among white UK-born people (see Appendix G). The rationale therefore was to give vaccination at this age to try to prevent acquisition of pulmonary disease before this peak, and it became known as the 'Schools BCG Programme'. During the writing of this guideline, the DH abolished the programme, replacing it with neonatal vaccination based on the criteria given above.

Tuberculosis rates fell through the 1950s and early 1960s by almost 10% per annum, and continued to fall at a lower rate until 1987 (approximately), since when there has been an increase. However, over this time, both the proportion of cases and rates of disease in the white UK-born ethnic group have continued to fall. The proportion of cases in this ethnic group was 85% in 1985, 43% in 1993, 37% in 1998, and is now under 30%.{140} Rates of TB in white UK-born children aged 10–14 years, the cohort of previously unvaccinated children to whom the schools programme applies, are between one and two cases per 100,000 for both sexes (see Appendix G).

International criteria for discontinuation of unselective BCG vaccination

The International Union against Tuberculosis and Lung Disease published their criteria for discontinuation of BCG programmes in countries of low prevalence in 1993.{291} This set out general considerations and criteria. The general criteria to be met in a country before stopping or modifying BCG programmes were:

- there is a well functioning TB control programme
- there has been a reliable monitoring system over the previous five years or more enabling the estimation of the annual incidence of TB by age and risk groups, with particular emphasis on TB meningitis and sputum smear-positive pulmonary TB
- due consideration has been given to the possibility of an increase in the incidence of TB resulting from HIV infection.

The criteria for discontinuing a BCG vaccination programme in a country with a low prevalence of TB were:

2006

- the average annual notification rate of sputum smear-positive pulmonary TB should be five cases/100,000 population or less during the previous three years, *or*
- the average annual notification rate of TB meningitis in children under age five years of age should be less than 1 case per 10 million general population over the previous five years, *or*
- the average annual risk of TB infection should be 0.1% or less.

Additional considerations were also suggested.

Cost: with it being advisable, but not essential, to calculate the number of cases which would be prevented by continuing BCG vaccination, so that the saving can be expressed in terms of preventing human suffering and also in saving of cost of treatment.

Adverse reactions to BCG: documentation of the rate of adverse reactions to BCG vaccination in a country are helpful. A low incidence rate of active tuberculosis, coupled with a high rate of adverse reaction tends to reinforce a decision to stop or modify the BCG vaccination programme. The reported rates of serious adverse reactions varies from country to country, with vaccination technique used, the preparation of BCG vaccination used, and doctors' awareness of reactions being factors influencing the reported rates.

Risk groups: in the event of discontinuation of the BCG vaccination programme for the general population, it may be advisable to continue vaccination in certain well-defined population groups with a known high notification rate of active tuberculosis.

11.3.2 Current practice

The Department of Health no longer recommends BCG vaccination for school children between ages 10–14 years.

11.3.3 Methodological introduction

The focus was on studies investigating the effectiveness of BCG vaccination administered in a school-aged population in preventing TB infection or disease. One RCT and two cohort studies were found that addressed the topic.

2006

One RCT conducted in the UK{285} reported on the protective efficacy of BCG vaccination against tuberculosis (TB) disease in vaccinated and unvaccinated groups of school-aged subjects in England over a 20-year follow-up period. Two cohort studies, both conducted in the UK,{292},{293} retrospectively identified notified cases of TB disease who had been eligible for BCG vaccination within the schools vaccination scheme when aged 13.{292},{293} These studies estimate the protective efficacy of the BCG vaccine in this general population and in the white ethnic group. Sutherland and Springett{292},{293} estimate the numbers of additional TB notifications that would be expected among young white adults annually, if the schools BCG scheme were to be discontinued at specific dates. Both cohort studies incorporated data from the RCT cited above.

11.3.4 Evidence statements

Efficacy of BCG vaccination for preventing TB disease

One RCT{285} and one cohort study{292} found that BCG given in school-aged children led to a reduction in the annual incidence of TB disease in vaccinated compared to unvaccinated individuals. Evidence is presented in Table 35.

Table 35: Summary of evidence: vaccinated and unvaccinated children of school-going age

BCG vaccinated *vs.* unvaccinated results	Statistical significance	Ref and NICE grade
Protective efficacy 0.77; average annual incidence 0.23 per 1,000 versus 0.98 per 1,000 (20 years follow-up)	Not reported	{285} 1+
1949–1981: Protective efficacy 0.80 (ages 15–19), 0.75 (ages 20–24)	Not reported	{292} 2+
1983: Protective efficacy 0.75 (ages 15–24); notification rate 3.3 per 100,000 versus 13.2 per 100,000	Not reported	{292} 2+

BCG vaccination in school-aged children and longitudinal trends in TB prevention

Evidence was found on BCG vaccination use in school-aged children in England and Wales and the following longitudinal trends:

- decrease in the efficacy of BCG and the incidence of TB notifications
- the estimated risk of notified TB in the white ethnic population eligible for the school's BCG vaccination scheme

2006

- TB notifications prevented by BCG vaccination in the white school-aged population
- TB notifications as a consequence of discontinuing the BCG schools vaccination scheme for the white ethnic population
- the estimated risk of notified TB in the white ethnic group if the school's BCG vaccination scheme were discontinued.

The evidence is presented in Table 36.

Table 36: Summary of evidence: vaccination and longitudinal trends in TB among children of school-going age

BCG use and longitudinal trend	Results Vaccinated *vs.* unvaccinated groups/BCG discontinued *vs.* continued	Statistical significance	Ref and NICE grade
Progressive decrease in protective efficacy in successive five-year follow-up periods	0.40, 0.33, 0.10, 0.09 *vs.* 2.50, 1.06, 0.26, 0.08 per 1000	p=0.01	{285} 1+
Annual decrease in TB notification rates in three cohorts covering a 29-year period	Ages 15–19: 5% *vs.* 10%	Not reported	{292} 2+
	Ages 20–24: 7% *vs.* 11%		
Estimated risk of notified TB between ages 15 and 30 in white UK-born people eligible for BCG schools programme	1984: 1/6,500 (BCG administered at age 13) *vs.* 1/700 (Mantoux test negative)	Not reported	{293} 2+
	1994: 1/17,000 (BCG administered at age 13) *vs.* 1/4,300 (Mantoux test negative)		
Estimated TB notifications prevented by BCG vaccination in the white school-aged population	1983: 557 at ages 15–29 due to 7.65 million vaccinations in previous 15 years	Not reported	{293} 2+
	1988: 370 at ages 15–29 due to 7.65 million vaccinations in previous 15 years		
Additional TB notifications due to discontinuing BCG schools vaccination in the white ethnic population	Discontinuation in 1986: 129 in 2,003 (ages 15–29)[19]	Not reported	{293} 2+
	Discontinuation in 1996: 51 in 2,013 (ages 15–29)		
Estimated risk of notified TB in the white ethnic population if BCG schools vaccination were discontinued	Discontinuation in 1986: 1/2,200 between ages 15 and 30 (first wholly unvaccinated five-year cohort aged 13 in 1987–91) *vs.* 1/2,700	Not reported	{293} 2+
	Discontinuation in 1996: 1/5,400 between ages 15 and 30 (five-year cohort aged 13 in 1997–2001) *vs.* 1/6,900		

2006

[19] Some of these would be secondary additional notifications outside the age group 15–29 years of age.

11.3.5 Health economics

A decision analytic model was used to estimate the cost-effectiveness of the current school BCG programme. The model distinguished between a 'high-risk' group of children who should have already been offered BCG before the school programme (through neonatal or new entrant schemes) and a 'low-risk' group, which is the remainder of the 10–14-year-old cohort. The school BCG programme is potentially beneficial for low-risk children and as a catch-up for previously unvaccinated high-risk children. The model relies on the assumption that there is negligible transmission between the high-risk and low-risk groups.{294}

The model is a simple decision tree that estimates the number of primary cases for a cohort of 10–14-year-olds, the consequent number of secondary cases in the population, and the associated costs and health outcomes, with and without a school BCG programme. The effectiveness of school BCG for the low-risk group and the number of secondary cases per primary case were taken from Saeed *et al* (2002),{295} updating the work of Sutherland and Springett in 1989.{293} The benefits for unvaccinated high-risk children were then estimated. It is important to note that this method can only give approximate results for an infectious disease such as TB. A population dynamic model would be expected to provide more reliable results.

Whenever possible, the input parameters and assumptions for the model were based on best available empirical evidence. However, we could not find evidence to inform all of the important parameters. In such cases, estimates are based on judgement by the guideline economist and the GDG. There is some uncertainty over the results of the model due to uncertainty over some of the input parameters for the analysis. In particular, the results are sensitive to the proportion of 10–14-year-olds in 'high-risk' groups, the estimated QALY loss due to TB, and the estimated cost of treating a case of TB.

Cost-effectiveness of school BCG for the low-risk group

The economic model suggests that the schools programme is not cost-effective for the low-risk group alone – with 0% in the high-risk group, the incremental cost per QALY gained (incremental cost-effectiveness ratio, ICER) is over £150,000 if we assume 15-year protection from BCG, and over £750,000 if we assume only 10-

year protection. School BCG appears to be cost-effective for the 'low-risk' population only if their 10–15-year risk is very high: approximately 0.13–0.15%. This compares with current estimates of 0.03% (age 15–24) or 0.05% (age 15–29) (see Table 37).

Table 37: Cost-effectivensss of school BCG for low-risk group only by baseline risk of TB

Risk of TB over period of BCG protection (%)	10-year protection			15-year protection		
	Additional cost (£K)	QALYs gained	ICER (£/QALY)	Additional cost (£K)	QALYs gained	ICER (£/QALY)
0.03	718	1	767,800	720	1	696,100
0.05	671	3	193,500	674	4	185,300
0.07	625	6	104,100	629	6	100,700
0.09	578	9	67,700	583	9	65,900
0.11	532	11	48,000	538	11	46,900
0.13	485	14	35,700	492	14	35,000
0.15	439	16	27,200	447	17	26,800
0.17	392	19	21,000	401	19	20,800
0.19	346	21	16,300	355	22	16,300

Cost-effectiveness of school BCG as a catch-up for unvaccinated high-risk children

Based on the assumptions that 64% of high-risk children have been previously vaccinated, that they have a relative risk of 40 (compared with the low-risk group), and that BCG offers protection for 10 years, the schools programme appears to be cost-effective for areas with around 25–30% or more children in the high-risk group. If we assume 15-year BCG protection, school BCG appears cost-effective with around 10–15% or more in the high-risk group (see Table 38).

Table 38: Cost-effectiveness of school BCG by percentage of cohort in high-risk group

'High-risk' as % of cohort	10-year protection			15-year protection		
	Additional cost (£K)	QALYs gained	ICER (£/QALY)	Additional cost (£K)	QALYs gained	ICER (£/QALY)
0	718	1	767,800	674	4	185,300
5	646	4	180,700	573	8	70,800
10	574	6	92,400	471	13	37,600
15	502	9	56,700	370	17	21,700
20	430	11	37,400	268	21	12,500
25	358	14	25,300	167	26	6,400
30	286	17	17,100	65	30	2,200

These results are sensitive to the estimated mean cost of treatment and QALY loss per case of TB age 15–24/29.

11.3.6 From evidence to recommendations

The GDG noted that the schools BCG programme was for those at low risk of TB and previously unvaccinated, whilst those at higher risk of TB (see section 10.2) receive BCG vaccination either at birth or on entry to the UK.

Whilst BCG in school-age children has a protective efficacy of 75–80% lasting 10–15 years, the incidence of active TB in those at low risk is now in the order of 1 case per 100,000, with a continuing downward trend.

England and Wales meet the accepted international criteria for the cessation of universal BCG vaccination in a low-prevalence country,{291} and have done so at least since 2000.

Economic modelling shows that the schools programme is not cost effective, and extremely expensive with an incremental cost-effectiveness ratio between £696,000 and £767,000 for low-risk individuals.

The schools programme becomes cost-effective only if 15% or more of the children included are at higher risk and previously unvaccinated.

For these reasons, it was felt that routine BCG vaccination of children aged 10 to 15 in schools should not continue. Those children at risk will either have been vaccinated neonatally (see section 11.2) or on entry to the UK (see section 11.4). Where universal childhood screening and vaccination is thought appropriate for an area because of very high local incidence, then this would be better achieved by a local universal neonatal BCG policy.

11.3.7 RECOMMENDATIONS

R94 Routine BCG vaccination is not recommended for children aged 10–14.

- Healthcare professionals should opportunistically identify unvaccinated children older than four weeks and younger than 16 years at increased risk of TB (see section 10.2) who would have qualified for neonatal BCG and provide Mantoux testing and BCG (if Mantoux negative). C

2006

- This opportunistic vaccination should be in line with the Chief Medical Officer's advice on vaccinating this age group following the end of the school-based programme[20]. D(GPP)

R95 Mantoux testing should not be done routinely before BCG vaccination in children younger than six years unless they have a history of residence or prolonged stay (more than one month) in a country with a high incidence of TB[21]. D(GPP)

11.4 For new entrants from high-incidence countries

11.4.1 Clinical introduction

The incidence of tuberculosis in new entrants from countries of high incidence (40/100,000 per year or greater) is high, peaking 2–3 years after first entry, and falling significantly after 10 years, but remaining well above general UK population rates (see Appendix G). Up to 30% of such recent arrivals from the Indian subcontinent are tuberculin negative.{296},{297} Since they will be living in communities with a rate of TB some 25 times that of the white UK-born community, they may benefit from BCG vaccination to reduce the risk of acquiring TB disease. Such a BCG policy would however have to take into account the possibility of false negative Mantoux test from HIV co-infection.

11.4.2 Current practice

In the Department of Health's *Immunisation against infectious diseases* (the Green Book) 1996,{3} the following recommendation is made for new entrants from countries with a high prevalence of tuberculosis, their children and infants wherever born.

'*New entrants to the UK,* including students, from countries with a high prevalence of tuberculosis, and all refugees and asylum seekers, should be tuberculin tested as part of the initial screening procedure unless there is **definite** evidence of a BCG scar. Those with positive reactions should be referred for investigation as they may

[20] Available from www.dh.gov.uk
[21] More than 40 cases per 100,000 per year, as listed by the Health Protection Agency (go to www.hpa.org.uk and search for 'TB WHO country data').

require chemoprophylaxis or treatment. BCG immunisation should be offered immediately to those who are tuberculin negative.'

Under section 32.4.1d of the same document HIV-positive individuals are listed as one of the contraindicated groups to whom BCG vaccine should not be given with the following comment:

'BCG is absolutely contraindicated in symptomatic HIV positive individuals. In countries such as the UK where the risk of tuberculosis is low, it is recommended that BCG is withheld from **all** subjects known or suspected to be HIV positive, including infants born to HIV positive mothers. There is no need to screen mothers for HIV before giving BCG as part of a selective neonatal immunisation programme (see 32.3.2(e))'.

The newly updated chapter of the draft 2006 Green Book{21} states:

'BCG immunisation should be offered to... previously unvaccinated, tuberculin-negative new entrants under 16 years of age who were born in or who have lived for a prolonged period (at least three months) in a country with an annual TB incidence of 40/100,000 or greater.'

Readers should also be aware of the recommendations made for neonates (see section 11.2).

11.4.3 Methodological introduction

Studies investigating the effectiveness of BCG vaccination in new entrants from high-risk countries in preventing TB infection or disease were targeted. No systematic reviews, randomised controlled trials, cohort or case control studies were found that directly addressed the area.

One meta-analysis conducted in the USA{298} demonstrated that BCG vaccine had protective efficacy across a wide range of study conditions, BCG strains, populations, age ranges and vaccine preparation methods. BCG efficacy in new entrants from countries with a high TB incidence was not addressed.

Since the meta-analysis did not use cross-design analysis, it was appropriate to grade evidence statements according to whether they were derived from the RCT (level 1), clinically controlled trial (level 2) or case control study (level 2) results.

Factors for consideration raised by the meta-analysis included:

- differences in the characteristics and methodological quality of individual studies were addressed by a sensitivity analysis, expressed as a study quality validity score
- among 13 prospective trials, study validity explained 30% of the between-study variance in the trials, and geographical latitude accounted for 41% of the variance
- among the 10 case-control studies, data validity score was the only variable to explain a substantial amount (36%) of the heterogeneity
- different strains of BCG were not associated with more or less favourable results in the 13 trials, as differing BCG strains administered in the same populations provided similar levels of protection.

One non-analytic study from the UK{299} was excluded due to methodological limitations presented in Appendix I.

11.4.4 Evidence statements

Evidence was found for the efficacy of BCG vaccination in preventing:

- pulmonary TB disease
- TB deaths
- TB meningitis
- disseminated TB.

Evidence for these four outcomes is presented in Table 39.

Table 39: Summary of evidence: BCG vaccination for new entrants

Outcomes	Intervention: BCG vaccinated *vs.* unvaccinated infants	Results	Association/statistical significance	Ref and NICE grade
Pulmonary TB disease	Seven RCTs	Protective effect 0.63	Combined RR 0.37 (95% CI 0.18 to 0.74)	{298} 1+
	Six clinically	Protective	Combined RR 0.49 (95%	{298}

	controlled trials	effect 0.51	CI 0.34 to 0.70)	2+
	Ten case control studies	Protective effect 0.50	Combined OR 0.50 (95% CI 0.39 to 0.64)	{298} 2+
TB deaths	Three RCTs and four clinically controlled trials	Protective effect 0.71	Combined RR 0.29 (95% CI 0.16 to 0.53)	{298} 2+
TB meningitis	Five case control studies	Protective effect 0.64 (based on 181 cases of TB meningitis)	Combined OR 0.36 (95% CI 0.18 to 0.70)	{298} 2+
Disseminated TB	Three case control studies	Protective effect 0.78	Combined OR 0.22 (95% CI 0.12 to 0.42)	{298} 2+

11.4.5 From evidence to recommendations

The GDG noted that there was little data in this field. The high rates of tuberculosis in recently arrived new immigrants from high incidence countries was also noted from epidemiological data over the last 25 years.

Although there is no direct evidence in this group in the UK, the meta-analysis cited above was regarded as applicable.

Analysis of the evidence on BCG efficacy has shown no evidence for persons aged over 35. The GDG felt that for this pragmatic reason, BCG vaccination should be limited to those under 36, unless they have occupational risk factors.

11.4.6 RECOMMENDATIONS

Readers should also be aware of the recommendations under new entrant screening (section 12.8). This process should include Mantoux tests on appropriate new entrants and risk assessment for HIV prior to vaccination.

R96 BCG vaccination should be offered to Mantoux-negative new entrants[22] who:

- are from high-incidence countries, *and*
- are previously unvaccinated (that is, without adequate documentation or a characteristic scar), *and* B
- are aged:
    - younger than 16 years, **D(GPP)** or

2006

[22] People who have recently arrived in or returned to the UK from high-incidence countries.

- 16 to 35 years[23] from sub-Saharan Africa or a country with a TB incidence of 500 per 100,000.

11.5 For healthcare workers

11.5.1 Clinical introduction

Although earlier studies had not shown an association, in the 1990s healthcare workers were shown to have twice the expected incidence of TB, allowing for age, sex and ethnic factors.{300} Because of the risk of exposure, it became standard practice to recommend BCG vaccination to people commencing healthcare work who would have contact with patients or clinical material, if they had not had prior BCG vaccination, and were Mantoux test negative.

11.5.2 Current practice

In *Immunisation against infectious disease* (the Green Book),{3} the Department of Health recommended BCG vaccination for all those at *higher risk of tuberculosis.* Under section 32.3.2a this included:

'**Health service staff** who may have contact with infectious patients or their specimens. These comprise doctors, nurses, physiotherapists, radiographers, occupational therapists, technical staff in microbiology and pathology departments including attendants in autopsy rooms, students in all these disciplines, and any others considered to be at high risk. It is particularly important to test and immunise staff working within maternity and paediatric departments, and departments in which patients are likely to be immunocompromised, eg transplant, oncology and HIV units.'

The newly updated chapter of the draft 2006 'Green book'{21} states:

'People in the following occupational groups are more likely than the general population to come into contact with someone with TB:

- healthcare workers who will have contact with patients or clinical materials

[23] The draft 2006 Green Book recommends BCG for new entrants only up to the age of 16. However in this guideline BCG is recommended for those up to 35 years who come from the countries with the very highest rates of TB because there is some evidence of cost-effectiveness.

2006

- laboratory staff who will have contact with patients, clinical materials or derived isolates...'

11.5.3 Methodological introduction

Studies investigating the efficacy of BCG vaccination in health care workers for preventing the development of TB infection or disease in comparison to unvaccinated healthcare workers were targeted. One systematic review was found that addressed the topic.

One systematic review conducted in the USA{301} included two randomised controlled trials, two prospective cohort studies, one historically controlled study, one retrospective cohort study and six non-analytic studies. Information on the study methods and results was reported for only four of the six non-analytic studies. The scope was international, but all 12 studies were conducted in the northern hemisphere, 10 in temperate zones situated far from the equator, the eleventh in California, and for the twelfth, the specific setting was unknown.

The systematic review was methodologically sound, and hence it could technically be given a grading of 1+. However, the review did not conduct a meta-analysis due to the heterogeneity of study designs and methodological limitations in each of the studies. The methodological limitations of individual studies contained within the review meant that there was insufficient robust data from which to derive evidence statements for this area. The review authors noted that despite methodological limitations, all six controlled studies reported a protective effect for BCG vaccination.

11.5.4 From evidence to recommendations

Whilst the systematic review was sound, all of the studies had multiple methodological flaws. There was however a consistent trend to benefit in the six controlled studies. Also, given the weight of evidence for the efficacy of BCG in other settings, it seemed unlikely that BCG would not be effective in this population. The GDG also noted that potential TB exposure continues throughout a career in individuals with patient or clinical material contact, and is not age limited.

There is not sufficient age-specific evidence to make recommendations on BCG vaccination for people over 35 but vaccination is recommended for healthcare

workers of all ages because of the increased risk to them – and consequently the patients they care for – if they remain unvaccinated.

11.5.5 RECOMMENDATIONS

R97 BCG vaccination should be offered to healthcare workers, irrespective of age[24], who: D(GPP)

- are previously unvaccinated (that is, without adequate documentation or a characteristic scar), *and*
- will have contact with patients or clinical materials, *and*
- are Mantoux (or interferon-gamma) negative.

Cross-referring:

For details of occupational health screening, see sections 13.1 and 13.2

11.6 BCG vaccination for contacts of people with active tuberculosis

11.6.1 Clinical introduction

Contacts of cases of pulmonary tuberculosis are at risk of contracting TB. This is particularly the case with household or close contacts of sputum smear-positive disease, where up to 10% become infected (see section 12.2). It may take several weeks to develop an immune response to infection, as judged by a positive tuberculin skin test. A second Mantoux test has to be performed in those whose initial test is negative, six weeks after the initial negative one and a decision made with the second result.{6} Those with serial negative skin tests are deemed not to have been infected, but BCG vaccination up to and including the age of 35 years is recommended. The index case should be rendered non-infectious within a few weeks by anti-tuberculosis drug treatment, but tuberculin-negative contacts remain at risk if there are secondary cases.

2006

[24] As outlined in the Green Book, there is not sufficient age-specific evidence to make recommendations on BCG vaccination for people older than 35 (see full guideline for details). However, in this guideline BCG vaccination is recommended for healthcare workers of all ages because of the increased risk to them – and consequently the patients they care for – if they remain unvaccinated.

11.6.2 Current practice

The Department of Health's *Immunisation against infectious disease* (the Green Book) 1996{3} recommended BCG vaccination for all those at *higher risk of tuberculosis*.{3} Under section 32.2d this included:

'**Contacts** of cases known to be suffering from active pulmonary tuberculosis. Contacts of a sputum smear positive index case may have a negative tuberculin skin test when first seen but be in the early stages of infection before tuberculin sensitivity has developed. A further skin test should be performed six weeks later and immunisation only carried out if this second test is negative. (If the second skin test is positive, the patient has converted and must be referred for consideration of chemoprophylaxis). However, if for some reason a further test is impossible, vaccine may be given after the first test. Newly born babies should be given prophylactic isoniazid chemotherapy and tuberculin tested after three to six months. If the skin test is positive, chemoprophylaxis is continued; if negative, BCG vaccine is given provided the infant is no longer in contact with infectious tuberculosis. Newly born contacts of other cases should be immunised immediately.'

The newly updated chapter of the draft 2006 Green Book{21} states:

'BCG immunisation should be offered to... previously unvaccinated tuberculin-negative contacts of cases of respiratory TB (following recommended contact management advice – currently Joint Tuberculosis Committee of the British Thoracic Society 2000 [{6}] and National Institute for Health and Clinical Excellence 2006 [this document]...'

11.6.3 Methodological introduction

The focus was on studies investigating the efficacy of BCG vaccination in contacts of those with diagnosed active tuberculosis disease in comparison to unvaccinated contacts from the same population. One cohort study and five non-analytic studies were identified. All studies addressed BCG vaccination of contacts prior to their exposure to the index case.

One prospective cohort study conducted in South Korea{302} over a period of approximately two and a half years reported on the protective efficacy of BCG

2006

vaccination against TB disease in child contacts. Four studies{278},{303},{304},{305} reported contact tracing results that included stratification of contacts by BCG vaccination status. BCG vaccination status was not the primary variable used to generate group allocation or to stratify the analysis of the results, and for this reason the studies were classified as non-analytic. One study was conducted in the UK (England, Wales and Scotland) and two studies in Scotland. A fourth study conducted in Brazil dealt with contacts of index cases diagnosed with MDR TB. Although the latitude effect could have influenced the study findings, the study was included since it focused on BCG vaccination in a contact population at risk of acquiring MDR TB disease. MDR TB is not addressed in the three UK-based studies.

A fifth non-analytic study was excluded due to methodological limitations, which are presented in the appendix I.

11.6.4 Evidence statements

Evidence on the efficacy of BCG vaccination in preventing TB disease was found for contacts:

- of index cases
- of index cases diagnosed with MDR TB
- belonging to different ethnic groups

The evidence is presented in Table 40.

Table 40: Summary of evidence: BCG vaccination for contacts of people with TB

Population	Results N (%) TB disease cases in BCG- vaccinated versus unvaccinated persons	Association/statistical significance	Ref and NICE grade
Contacts of index cases	Child contacts aged 0–5: protective effect 0.70; 46/806 (5.7) *vs.* 80/417 (19.2) scored six or higher, indicating TB disease	Not reported	{302} 2+
	Stratification by age: protective effect 0.74	Summary RR 0.26 (95%CI 0.62 to 0.82)	{302} 2+
	Close contacts: 14/1081 (1.3) *vs*. 149/3587 (4.2)	Not reported	{278} 3+
	Contacts: 16/1821 (0.88) *vs.* 62/3595 (1.72)	Not reported	{303},{304} 3+
	Contacts with new TB (active TB disease plus those on	p<0.001	{303},{304} 3+

	treatment for latent TB infection): protective effect 0.62; (1.15) *vs.* (3.06)		
	Contacts: 14/1605 (0.87) *vs*. 34/1761 (1.93)	Not reported	{303},{304} 3+
	Contacts received chemotherapy/treatment for latent TB infection for TB disease/infection: protective effect 0.59; 23/1605 (1.4) *vs.* 60/1761 (3.4)	Not reported	{303},{304} 3+
Contacts of index cases diagnosed with MDR TB	Protective effect 0.69 (excluding three contact TB cases with drug-susceptible isolates); 8/153 (5) *vs.* 9/65 (14)	RR 0.35 (95%CI 0.13 to 0.99, p< 0.05)	{305} 3+
	TB disease found significantly more in unvaccinated MDR TB contacts	RR 3.1 (95%CI 1.2 to 8.1)	{305} 3+
Contacts belonging to different ethnic groups	Asian contacts: 7/425 (1.6) *vs.* 57/1479 (3.9)	Not reported	{278} 3+
	Non-Asian (mainly white) contacts: 7/656 (1.1) *vs.* 92/2108 (4.4)	Not reported	{278} 3+
	Asian contacts: 0/86 *vs.* 5/228 (2.19)	Not reported	{303},{304} 3+
	Non-Asian (mainly white) contacts: 16/1735 (0.92) *vs.* 57/3367 (1.69)	Not reported	{303},{304} 3+
	Incidence of TB in black African *vs.* white contacts: 2.2 versus 0.4 per 1,000 person-years	p<0.001[25]	{305} 3+

11.6.5 From evidence to recommendations

The appraised evidence shows some protective efficacy for BCG vaccination given before contact with tuberculosis, but none of the studies addressed the efficacy of BCG administered to tuberculin-negative contacts after exposure to TB. However, such individuals may be at increased risk from secondary TB cases if not vaccinated. As for new entrants, the potential benefit of BCG vaccination is reduced with age, and there is no reason to change the upper age limit of 35 years, which is currently widely used.

RECOMMENDATION

R98 BCG vaccination should be offered to Mantoux-negative contacts of people with respiratory TB (see section 12.2 for details of contact tracing) if they are

2006

[25] Using Cox's regression test, ethnicity was no longer associated with incidence of TB disease.

previously unvaccinated (that is, without adequate documentation or a characteristic scar) and are: D(GPP)

- aged 35 or younger
- aged 36 and older and a healthcare or laboratory worker who has contact with patients or clinical materials (see section 11.5).

Cross-referring:

For details of contact tracing, see sections 12.2–12.6.

11.7 Other groups

The Department of Health currently recommends BCG vaccination for a range of other people who may be at risk from TB.{21} This guideline concentrated on the groups given individually above but for completeness this section addresses the other groups at risk, who stand to benefit from BCG vaccination. For veterinary surgeons, abattoir workers and other people working with animals, there are a number of possible sources of infection, but no standard occupational health screening. Workplace screening is likely to be provided by private sector firms, and is therefore outside the remit of NICE. However, a number of regulations apply:

- the Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 1995, which require employers to notify the Health and Safety Executive
- the Management of Health and Safety at Work Regulations 1999, which require general standards of risk assessment
- the Control of Substances Hazardous to Health Regulations 2002, which require employers to assess infection risk and prevent or control exposure.

11.7.1 RECOMMENDATION

R99 BCG vaccination should be offered to previously unvaccinated, Mantoux-negative people aged35 or younger in the following groups at increased risk of exposure to TB, in accordance with the 'Green Book':{21}D(GPP)

- veterinary and other staff such as abattoir workers who handle animal species known to be susceptible to TB, such as simians
- prison staff working directly with prisoners
- staff of care homes for elderly people

- staff of hostels for homeless people and facilities accommodating refugees and asylum seekers
- people going to live or work with local people for more than 1 month in a high-incidence country.[26]

See section 11.5 for advice on healthcare workers.

12 Active case finding

12.1 Overview

12.1.1 Clinical introduction

Active case finding is looking systematically for cases of active tuberculosis and latent infection in groups known, or thought to be, at higher risk of tuberculosis, rather than waiting for people to develop symptoms/signs of active disease and present themselves for medical attention (passive case finding). Active case finding is informed by a knowledge of the general epidemiology of TB in the country, and in population subgroups. The current incidence of active TB in England and Wales is 12.9 cases per 100,000 population per year, with individual ethnic groups having rates of 4 per 100,000 (white), 104 per 100,000 (Indian), 145 per 100,000 (Pakistani), and 211 per 100,000 (black African).{140} Data are not available on latent tuberculosis rates in the general population. Active case finding, if targeted on appropriate groups, or subgroups, should have a yield substantially above that that would be found by chance screening. The Chief Medical Officer's TB Action Plan{2} set improvements in case finding as one of the essential activities to improve TB care in England and Wales, and to reverse the trend of increasing incidence.

12.1.2 Current practice

The review of current services included service provision and organisation for active case finding in terms of contact tracing (sections 12.2 and 12.3), new entrant screening (section 11.7), and screening other risk groups.

Outside London, 25% of service providers had some screening for high-risk groups, whereas within London, 39% had such screening. Examples of high-risk groups were drug users, the homeless and alcoholics.

[26] Go to www.hpa.org.uk and search for 'WHO country data TB'.

12.2 Contact tracing: human-to-human transmission

12.2.1 Clinical introduction

Contact tracing and examination have traditionally been undertaken to find associated cases, to detect people infected but without evidence of disease (latent infection) and to identify those not infected and for whom BCG vaccination may be appropriate. Where recent infection has occurred (eg clinical disease in children), contact tracing is done to find a source of infection, and any co-primary cases. In people with latent tuberculosis, BCG vaccination does not prevent its development into active disease. BCG vaccination is addressed in chapter 10 of this guideline.

Five contact studies in England and Wales,{306–310} reporting 22,971 contacts in the early 1990s, showed that up to 10% of new TB cases were diagnosed through contact tracing, that disease occurred in about 1% of contacts, and that disease was usually found on the first visit in unvaccinated contacts of sputum smear-positive disease. Three smaller studies reported in the late 1990s in England and Wales,{311–313} largely confined to close contacts, showed a mean number of contacts examined at 6.5 per index case, and confirmed a secondary case yield of 1% (1,000/100,000).

Smear-negative pulmonary tuberculosis is significantly less infectious than smear-positive, but some transmission does occur. Studies in San Francisco{314} and Western Canada{315} using DNA fingerprinting estimated this transmission risk (as a proportion of smear-positive transmission risk) at between 0.22 and 0.18–0.35 respectively, similar to estimates (0.28) using 'conventional' methods.{316} DNA fingerprinting studies may also identify clusters not identified by 'conventional' contact tracing and in some cases assumed to be recently linked.{314},{315}

12.2.2 Current practice

The review of current services found that outside London, 70% of service providers had contact clinics and 16% saw patients at home. Within London, 91% had a contact tracing clinic, and no service providers saw patients at home other than in exceptional cases.

An assessment of the extent of current contact tracing practice can be made by comparing the number of notified cases with the number of contacts screened. The graph below, where each dot represents a service provider, and clinics which only do tracing have been removed, shows that there is considerable variation in the number of contacts traced per index case. (Perfect consistency, which is an unreasonable expectation, would be demonstrated in a straight line.)

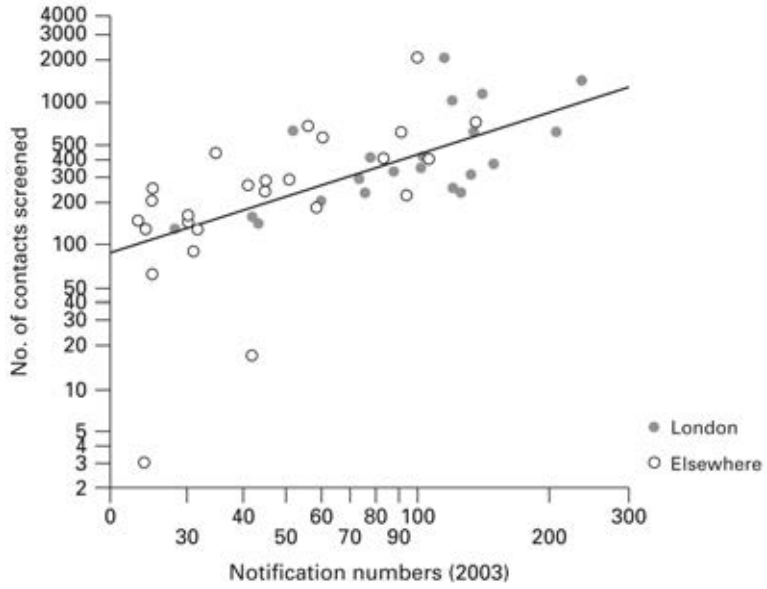

Figure 9 Correlation of contacts screened with cases notified (logarithmic scale)

A similar comparison has been made between the number of contacts traced and the number of treatments for latent TB infection cases, and is reported under section 10.1.

12.2.3 Methodological introduction

Two clinical questions were drawn up to search the evidence base for this topic. The results of the searches and the critical appraisal are discussed below for each in turn.

Are contact tracing procedures effective in identifying cases of tuberculosis disease or infection (excluding contacts of cattle with TB)?

No systematic reviews or randomised controlled trials were found that met the inclusion criteria for this question.

The literature search identified 10 studies conducted in England and Wales that reported epidemiological descriptions of specific contact tracing exercises. These

studies did not include comparative case yield data from other contact tracing or case finding exercises in similar populations and settings, and so were not considered for appraisal. Without comparative data, these studies could not evaluate the effectiveness of the specific contact tracing intervention method used. Nevertheless these studies contribute towards an epidemiological overview of contact tracing in England and Wales, and the main results of these studies are collated in Table 41 below in order to provide local background information on this aspect of active case finding.

Table 41: Descriptive studies of contact tracing carried out in England and Wales

Reference	Description	Results
Ruddy MC, Davies AP, Yates MD, Yates S *et al*. Outbreak of isoniazid resistant tuberculosis in north London. *Thorax* 2004;**59(4)**:279–285.	Study type: descriptive. Population: contact tracing of isoniazid resistant TB outbreak in North London, including prisons. Study period: retrospective analysis 1995–2001.	• At least 440 named close contacts of confirmed or probable TB cases to date. • Screening of 269 close contacts yielded 13 confirmed or probable TB cases, 13 clinical cases, and three linked cases. • This represents a transmission rate of 11% among close contacts screened to date. • 27 infected contacts were placed on treatment for latent TB infection.
Corless JA, Stockton PA, Davies PD. Mycobacterial culture results of smear-positive patients with suspected pulmonary tuberculosis in Liverpool. *European Respiratory Journal* 2000;**16**:976–979.	Study type: descriptive. Population: contact tracing of suspected pulmonary TB from two hospitals in Liverpool. Study period: retrospective analysis 1996–1999.	• A total of 937 contacts were identified from 57 index patients with cultured *M. tuberculosis*. • No contact in the study developed tuberculosis while under surveillance.
Ansari S, Thomas S, Campbell IA, Furness L, Evans MR. Refined tuberculosis contact tracing in a low incidence area. *Respiratory Medicine* 1998;**92(9)**:1127–1131.	Study type: descriptive. Population: patients with TB and their contacts in South Glamorgan. Study period: retrospective analysis 1992–1994.	• A total of 726 contacts were identified from 103 index patients, with 707 contacts receiving full screening. • TB disease was found in 7 (1%) close contacts, all identified

		at the initial screening (one with smear-positive index case; five with two overseas index cases with unknown smear status; one with child index case with unknown smear status). • TB disease was found later in a further five contacts initially screened and cleared (in two cases the protocol was not followed correctly and three cases developed extra- pulmonary TB. • Treatment for latent TB infection was given to 21 (2.9%) of close contacts.	2006
Irish C, Jolly E, Baker T. Contact tracing smear positive and non-pulmonary tuberculosis in a high incidence area. *Thorax* 1997;**52**:A34.	Study type: descriptive epidemiological study. Population: contacts of non-pulmonary (NP), sputum smear-positive (POS), and negative (NEG) cases of tuberculosis disease in Tower Hamlets. Study period: 1995.	• One of 158 (0.5%) contacts of POS cases, four of 196 (2%) contacts of NEG cases, and none of 57 contacts of NP cases were treated for tuberculosis disease. • Twenty-two of 158 (14%) POS contacts, 21 of 196 (11%) NEG contacts, and five of 57 (9%) NP contacts received treatment for latent TB infection. • Differences in proportions of POS, NEG, and NP contacts requiring one or more repeat X-ray, further clinic follow-up, treatment for latent TB infection or full tuberculosis treatment were not significant.	
Stoddart H, Noah N. Usefulness of screening large numbers of contacts for tuberculosis: questionnaire-based review. *British Medical*	Study type: cross-sectional survey Population: 155 districts in England and Wales where in the preceding three years more than 100 contacts were screened in response to	• Forty-four cases of tuberculosis disease were found in 18 of the 56 investigations, giving a detection rate of 0.375%.	

Journal 1997;**315**:651.	specific incidents. Study period: April 1994.	• A further 106 (0.9%) contacts received treatment for latent TB infection. • The development of tuberculosis in 39 investigations with details available was significantly correlated with the proportion of contacts who had tuberculin skin test positive results (P=0.008).	
Harding MJ, Pilkington P, Thomas J. Tuberculosis epidemiology in Croydon. *Public Health* 1995;**109**:251–7.	Study type: descriptive. Population: contact tracing in response to tuberculosis incidents in Croydon. Study period: retrospective analysis 1988–1991.	• A total of 522 close contacts were identified from 172 index cases. • Three cases of tuberculosis were identified from the contacts (0.6%). • Forty-eight contacts (9.2%) had either a positive Heaf test or chest X-ray indicative of past primary infection. • 19.6% of contacts of index patients with smear-positive disease were 'positive' *vs.* 9.8% of contacts of non-smear positive index patients, *vs.* 5.2% of patients with non-pulmonary disease (P=0.0002).	**2006**
Hardinge FM, Black M, Chamberlain P. TB contact tracing in South Buckinghamshire from 1994 to mid 1998. *Am J Respir Crit Care Med* 1999;**159**:A303.	Study type: descriptive. Population: all patients with TB and their contacts in South Buckinghamshire. Study period: retrospective analysis 1994 to mid 1998.	• 369 contacts were identified from 72 index cases. • Eight cases of TB were identified among contacts, four at initial screening (1%) – all were close contacts of smear-positive pulmonary disease index cases. • Three contacts were given treatment for latent TB infection (0.8%), and 143 (38%)	

		were given BCG vaccination.
Ormerod LP. Results of tuberculosis contact tracing: Blackburn 1982–90. *Respiratory Medicine.* 1993;**87**:127–131.	Study type: descriptive. Population. contact tracing in Blackburn using methods 'virtually identical' to procedures recommended in 1983 by the JTC. Study period: retrospective analysis 1982–1990.	• 7,017 close contacts were identified from 649 index cases. • 50 cases of TB (0.7% of all contacts) were identified, 13 in the white ethnic group, and 37 in the Asian ethnic group. • 38% of cases in the Indian subcontinent ethnic group were contacts of smear-positive pulmonary disease, and 46% were contacts of other forms of respiratory disease. • All cases of TB were in white contacts of index cases with smear-positive pulmonary disease.
Kumar S, Innes JA, Skinner C. Yield from tuberculosis contact tracing in Birmingham. *Thorax* 1992;**47**:875.	Study type: descriptive. Population: yield from contact tracing of notified TB cases at the Birmingham chest clinic using a contact tracing procedure 'broadly similar' to 1990 BTS guidelines. Study period: retrospective analysis 1987–1989.	• 7,960 contacts were identified from 788 index cases. • 75 new cases of TB were identified from contacts (1% of all contacts), 46 of Indian subcontinent origin, 15 white, and 14 black Caribbean. • 254 contacts were given treatment for latent TB infection (3% of all contacts). • All contacts with TB disease were contacts of index cases with pulmonary smear-positive TB except for six (8% of total) Indian contacts of index cases with non-respiratory disease.
Hussain SF, Watura R, Cashman B, Campbell IA, Evans MR. Audit of a tuberculosis contact	Study type: descriptive. Population: TB contact tracing in South Glamorgan. All patients with a diagnosis of	• 611 contacts were identified from 101 index patients. • Active TB disease was

2006

tracing clinic. *BMJ.* 1992;**304**:1213–15.	active TB disease who appeared in the contact tracing records and laboratory data from the Public Health Laboratory Service (PHLS) *Mycobacterium* Reference Unit within this period were included in the study, as were all recorded contacts of these patients. Study period: retrospective analysis 1987–89.	diagnosed in five contacts (two of Indian subcontinent origin, three of other origins), all made on initial screening. All were close contacts and none were known to have been vaccinated. • Four contacts who received treatment for latent TB infection were also close contacts of patients with smear-positive pulmonary TB and had not been vaccinated.
Teale C, Cundall DB, Pearson SB. Time of development of tuberculosis in contacts. *Respiratory Medicine* 1991;**85**:475–7.	Study type: descriptive. Population: contact tracing procedures at the Leeds chest clinic Study period: retrospective analysis 1983–1987.	• 6,602 contacts were identified from 555 notified index cases. • 42 (8%) contacts had TB disease (10 cases smear or culture positive, five contacts of Asian origin, five contacts of non-family members; four cases diagnosed more than one year after first clinic attendance). • 35 (6%) previously unimmunized child contacts with Heaf grade 2 or more results received treatment for latent TB infection.

Of the 17 studies appraised, 11 were excluded due to methodological limitations, which are presented in Appendix I. Six non-analytic studies were included as evidence in two main areas:

- non-homeless and homeless populations
- contact tracing and DNA fingerprinting analysis.

Are contact tracing procedures which identify casual contacts in addition to close contacts effective in identifying cases of tuberculosis disease or infection?

Studies were included that compared the number of cases of latent tuberculosis infection and/or active tuberculosis disease identified during contact tracing in

groups of close and casual contacts. No systematic reviews, randomised controlled trials, cohort or case control studies were found that met the inclusion criteria for this question.

Seven studies on contact tracing in close and casual contacts were identified, but six of these{316–321} were excluded due to methodological limitations presented in Appendix I. One prospective non-analytic study {322} was included as level 3 evidence for this question.

12.2.4 Evidence statements

Contact tracing compared in non-homeless and homeless populations

A study carried out in the USA{323} found that contact tracing identified significantly more contacts in non-homeless compared to homeless tuberculosis cases. The evidence is presented in Table 42.

Table 42: Summary of evidence: contact tracing in homeless and non-homeless people

Outcome	Results Homeless *vs.* non-homeless TB index cases	Statistical significance	NICE grade
Mean number contacts identified	2.7 *vs.* 4.8	p<0.001	3+
Four plus contacts identified	40 (26) *vs.* 1419 (50)	p<0.0001	3+
No contacts identified N (%)	70 (46) *vs.* 304 (11)	p<0.0001	3+

Contact tracing and DNA fingerprint analysis

Five non-analytic studies compared DNA fingerprint analysis of transmission links between cases of tuberculosis with the number of epidemiological links established through contact tracing for the same set of cases. These studies did not have a control group. Factors for consideration within this topic are used below.

- DNA fingerprint analysis can only be carried out on culture-positive cases of *M. tuberculosis*. Contact tracing includes culture-positive and-negative cases, and identifies cases of latent infection. Contact tracing therefore covers a wider population of at-risk contacts than DNA fingerprinting analysis, so the procedures are not equivalent comparators.

- Reliance on *M. tuberculosis* isolates means that molecular typing usually occurs some time after contact tracing has commenced, and so cannot complement in real time the epidemiological links established by the latter.
- None of the studies were carried out in the United Kingdom.
- Contact tracing was generally poorly reported and differed within each study setting.

Four studies{324–327} found that when contact tracing and DNA fingerprint analysis were carried out on the same group of contacts, tracing found fewer transmission links between identified cases of active tuberculosis than DNA fingerprint analysis. The evidence from the studies is presented in Table 43 below.

Table 43: Summary of evidence: DNA fingerprinting

Results: DNA fingerprint analysis	Results: Contact tracing	Ref and NICE grade
155 clustered TB cases	Identified links in 37/155 (24%) clustered cases; missed detectable links in 10/155 (6%) clustered cases; non-detectable (by contact tracing) links in 106/155 (68%) clustered cases.	{324} 3+
Four clusters of TB cases with transmission links identified	Identified links in 3/4 (75%) clusters.	{325} 3+
84 TB cases in 26 clusters	Identified links in 20/84 (24%) linked TB cases.	{326} 3+
96 TB cases in eight clusters	Two TB cases identified an unspecified number of cases in the same cluster as 'contacts'.	{327} 3+

One study{328} found that DNA fingerprint analysis identified erroneous transmission links inferred by contact tracing to exist between cases of tuberculosis disease.

Eight of 13 epidemiological transmission links (61.5%) identified by contact tracing were verified by DNA fingerprint analysis, but the remaining five (38.5%) cases linked by contact tracing did not acquire their infection from the putative source. (**3+**)

Close contacts compared to casual contacts in detecting latent tuberculosis infection

One study{322} found that both latent tuberculous infection and active tuberculous case yields were significantly higher for close compared to casual contacts of 302

index cases diagnosed at a single non-hospital practice. The evidence is summarised in Table 44 below.

Table 44: Summary of evidence: contact tracing in close and casual contacts

Outcomes	Close contacts N (%)	Casual contacts N (%)	Association/statistical significance (OR)	NICE grade
Latent TB infection	488 (55.9)	94 (26.4)	OR 3.54 (95%CI 2.68 to 4.69 p<0.00001)	3+
Active TB disease	40 (4.6)	2 (0.6)	OR 8.51 (95%CI 2.18 to 73 p<0.001)	3+

12.2.5 From evidence to recommendations

General issues

Contact tracing procedures should be carried out on a patient-centred basis. The GDG felt it was important to consider the lifestyle of an index/source case carefully as it may reveal places of close contact other than domestic or occupational such as homeless shelters, cinemas, bars, clubs, prisons or aircraft.{329}

Contact tracing is usually conducted according to the 'stone in the pond' principle,{330} and it is with this in mind that the recommendations below are set out. Closest contacts (those with most exposure, typically household contacts) are found and assessed first. If sufficient TB is found to raise clinical suspicion of further infection, another tier of contacts are traced, and so on. This helps to limit the effort put into such exercises.

Definition of close contacts

Descriptive studies from the UK which were considered by the GDG do not give a clear definition of close contacts and it is therefore difficult to give guidance on whom to trace.

It would be useful to give TB nurses an objective definition of close contacts, but there is insufficient evidence to make a recommendation on factors such as length of time spent in the same room without ventilation before 'close contact' is deemed to have occurred.

DNA fingerprint analysis

DNA 'fingerprint' analysis has been used to identify clusters that have not been identified by contact tracing. It can support the presumed links between cases.

Only one study checked the effectiveness of molecular typing through follow-up, and the GDG did not feel that the evidence base was sufficient to inform clinical recommendations.

Molecular typing will underestimate the epidemiological linkages relevant to contact tracing, because it relies exclusively on analysis of culture-positive TB isolates.

Who to include in contact tracing?

Whilst the highest pick-up will be in the contacts of pulmonary smear-positive cases, there is a significant yield from screening household contacts even of non-respiratory index cases, as this is assessing and screening a local population with a high incidence of TB.

Contacts with a cumulative total exposure to a smear positive case of TB exceeding eight hours within a restricted area equivalent to a domestic room are equivalent to domestic contacts; the guideline recommends tracing these contacts in addition to the domestic ones.

'Inform and advise' information is an important minimum level of TB education for all contacts once they are traced. However, for close contacts, this should not pre-empt screening and discussion with a healthcare professional (as a normal part of contact tracing), because of patient confidentiality.

12.2.6 RECOMMENDATIONS

R100 Once a person has been diagnosed with active TB, the diagnosing physician should inform relevant colleagues so that the need for contact tracing can be assessed without delay. Contact tracing should not be delayed until notification. D(GPP)

R101 Screening should be offered to the household contacts of any person with active TB, irrespective of the site of infection. Household contacts are defined as those who share a bedroom, kitchen, bathroom or sitting room with the index case. Screening should comprise: D(GPP)

- standard testing for latent TB for those aged 35 or younger, and consideration of BCG or treatment for latent TB infection once active TB has been ruled out

- interferon-gamma test six weeks after the Mantoux test, and consideration of BCG or treatment for latent TB infection once active TB has been ruled out, for those who:
  – are previously unvaccinated *and*
  – are household contacts of a person with sputum smear-positive TB *and*
  – are Mantoux negative (<6 mm)
- chest X-ray (if there are no contraindications) for those older than 35, possibly leading to further investigation for active TB.

2006

R102 For people with sputum smear-positive TB, other close contacts should be assessed. These may include boyfriends or girlfriends and frequent visitors to the home of the index case. Occasionally, a workplace associate may be judged to have had contact equivalent to that of household contacts, and should be assessed in the same way. D(GPP)

R103 Casual contacts of people with TB, who will include the great majority of workplace contacts, should not normally be assessed. C

R104 The need for tracing casual contacts of people with TB should be assessed if: D(GPP)

- the index case is judged to be particularly infectious (for example, evidenced by transmission to close contacts), *or*
- any casual contacts are known to possess features that put them at special risk of infection (See section 10.1).

R105 'Inform and advise' information should be offered to all contacts of people with smear-positive TB. D(GPP)

Cross-referring:

For details of diagnosing latent TB, see section 5.1.

For details of diagnosing active TB, see section 5.2.

For details of dealing with children aged less than 2 years who are close contacts of people with sputum smear-positive TB, see section 10.1.

For details of BCG vaccination, see section 11.6.

For examples of 'inform and advise' information, see Appendix H.

2006, amended 2011

Figure 10 Algorithm for testing and treating asymptomatic children aged between 4 weeks and 2 years old who are contacts of people with sputum smear-positive TB

This algorithm is currently being reviewed and has been temporarily removed.

2006, amended 2011

Figure 11 Algorithm for asymptomatic household and other close contacts of all cases of active TB

12.3 Contact tracing: cattle-to-human transmission

2006

12.3.1 Clinical introduction

Tuberculosis in cattle, as judged by postmortem studies and tuberculin reactors, has become more common in England and Wales over the last 20 years. The highest rates in cattle are in the south west of England, parts of Wales and the West Midlands. Bovine tuberculosis is almost entirely caused by *M. bovis*, which can be differentiated from *M. tuberculosis* in the laboratory after culture. Following the increase in cattle TB, surveillance for human *M. bovis* infection was enhanced. However the reporting system of the PHLS (MycobNet, see chapter 13) reported only 210 humans with isolates of *M. bovis* between 1993–1997, approximately 1% of reported human *M. tuberculosis* complex isolates.{331} People with *M. bovis*

isolates were very different from those with other *M. tuberculosis* complex isolates. Of the 210, 200 were of white ethnic origin, with over three quarters aged 50 years or more, findings suggesting reactivation of disease acquired earlier in life.

The overwhelming majority of the UK population is at negligible risk from *M. bovis* infection because of milk pasteurisation. Continuing data from MycobNet since 1997{140} shows no increase in the numbers of human *M. bovis* isolates.

Readers should be aware of the Department of Health's advice on the public health implications of bovine TB.{332}

12.3.2 Current practice

The review of current services did not specifically ask for details, but some respondents supplied information on their work with bovine TB. It was regarded as being responsible for a significant workload in three HPU areas. Three clinics reported 28 cases of *M. bovis* infection, for which they had traced an average of six contacts per case. This would be a not insignificant workload for contact tracing services in a dispersed rural population.

12.3.3 Methodological introduction

No systematic reviews, randomised controlled trials, case control studies or non-analytic studies were found that met the inclusion criteria for this question. One cohort study{333} conducted in the USA was excluded due to methodological limitations listed in Appendix I. Two Canadian papers investigated human contacts of diseased elk, and one UK paper was purely descriptive of case yield but did not evaluate contact tracing as an intervention. There are therefore no evidence statements for this question.

12.3.4 From evidence to recommendations

Since there is little evidence of cattle–human or human–human transmission of *M. bovis* from national epidemiology or the limited UK data, the group considered that tuberculin skin testing and interferon-gamma testing should be limited to previously unvaccinated children and adolescents (age <16) who have regularly drunk unpasteurised milk from animals with udder lesions, with treatment for latent TB infection being offered to those with a positive result.

12.3.5 RECOMMENDATIONS

R106 'Inform and advise' information should be given to people in contact with TB-diseased animals. Diagnostic tests for latent TB should be considered only for children younger than 16 who have not had BCG vaccination and have regularly drunk unpasteurised milk from animals with TB udder lesions. D(GPP)

Cross-referring:
For details of diagnosing latent TB, see section 5.1.
For details of diagnosing active TB, see section 5.2.
For details of BCG vaccination, see section 11.6.
For examples of 'inform and advise' information, see Appendix H.

12.4 Contact tracing: cases on aircraft

12.4.1 Clinical introduction

The evidence base upon which assessments can be made of the risks of transmission of TB in aircraft is relatively slim. The confined space and the recirculation of air clearly give rise to potential hazards. Whether or not these are greater for an individual on a single flight than, say, regular travel on the same commuter bus or train as an infectious case of TB cannot be established.

Aircraft passengers are, in theory at least, more readily identifiable than passengers of other kinds. Identifiability and traceability are not, however, synonymous and characteristically, aircraft passengers do not make multiple repeat journeys and are widely dispersed once they reach their destination. Further, airlines (who hold the passenger lists) may prove reluctant to disseminate information about the hazards of having travelled with them.

Recommendations about contact tracing where an aircraft passenger has been identified as having infectious TB must therefore be guided by the practicalities of the process.

12.4.2 Methodological introduction

Studies were targeted that attempted to establish whether latent tuberculosis infection and active tuberculosis disease identified by contact tracing in passenger

and crew contacts was due to recent transmission from an index case of tuberculosis on an aircraft. No systematic reviews, randomised controlled trials, or case control studies were found that met the inclusion criteria.

One cohort study conducted in the USA{334} compared case yields for latent tuberculosis infection identified by contact tracing in flight crew exposed to an index case of tuberculosis with flight crew with no prior exposure to infectious tuberculosis. Five non-analytic studies{335–339} were identified that investigated whether latent tuberculosis infection identified in passenger and crew contacts was due to prior risk factors for tuberculosis or recent exposure to an index case of tuberculosis on an aircraft. Methodologically, all six studies differed with regard to:

- varying geographical locations
- varying countries of residence of contacts
- differing exposure periods
- variation in prior BCG vaccination of contacts depending on country of residence
- sample sizes ranging from 100 to 760.

Prior risk factors for latent tuberculosis infection and contamination of tuberculin skin test results identified in the study populations included:

- high BCG vaccination rates
- prior exposure to family members or close friends with tuberculosis
- born or resident in a country with a high incidence of tuberculosis
- extensive travel in settings with a high incidence of tuberculosis
- having old, inactive tuberculosis
- exposure to tuberculosis in the workplace (excludes flight crew)
- exposure to other mycobacterial infection.

12.4.3 Evidence statements

Recent transmission of latent tuberculosis infection

One study {334} found significantly more cases of recent transmission of tuberculosis infection in aircraft crew exposed to an index case of tuberculosis than in a control group of non-exposed crew. Two studies{336},{337} found evidence of

recent transmission of TB infection in airplane contacts of cases with tuberculosis disease, while three other studies{335},{338},{339} found no conclusive evidence of recent transmission in airplane contacts of active TB disease cases. None of the studies reported symptoms of active tuberculosis in contacts. The evidence is presented in Tables 45 and 46 below.

Table 45: Exposed and non-exposed aircraft crew

N (%) exposure group Mantoux test positive	N (%) control group Mantoux test positive	Association/statistical significance	Ref and NICE grade
May–July 1993: 10/169; 5.9	**May–July 1993:** 13/247; 5.3	NS	{334} 2++
August–October 1993: 13/43; 30 (Mantoux test positive rates ≥5 mm induration)	**August–October 1993:** 13/247; 5.3 (Mantoux test positive rates ≥5 mm induration)	RR 5.74 (95%CI 2.86 to 11.54, p<0.01)	
11/43; 25.6 (Mantoux test positive of 10 mm induration)	4/247; 1.6 Mantoux test positive (rates of 10 mm induration)	RR 15.8 (95%CI rates 5.27 to 47.34, p<0.01)	

Table 46: Aircraft contacts with latent TB infection attributed to prior risk factors vs. aircraft-mediated transmission

N (%) Mantoux test positive contacts with prior risk factors for TB	N (%) Mantoux test positive contacts attributed to aircraft transmission	Ref and NICE grade
6/9 (66.6)	3/9 (33.3) Flight exposure-related conversion rate for latent TB infection was 1.3% (3/225 contacts)	{336} 3+
14/20 (70%)	6/20 (30) Flight exposure related conversion rate for latent TB infection was 0.8% (6/760 contacts)	{337} 3+
24/24 (100%)	0	{335} 3+
32/34 (94%)	2/34 (5.8) Impossible to determine whether two US-born Mantoux test positive reactors were due to aircraft transmission, since estimated 4–6% of the US population are Mantoux test positive	{338} 3+
5/5 (100%)	0	{339} 3+

Duration of exposure

One study{334} found that duration of exposure to the index case was the factor most strongly associated with latent tuberculosis infection among exposed aircraft crew contacts.

Over three months 49 (96%) crew contacts all had at least 14.5 total hours of exposure to the index case. Total time exposed to the index case during this period

2006

was the variable most strongly associated with the probability of having a Mantoux test positive result (p<0.001) for all variables and interactions considered. (**2++**)

Seating proximity of infected contacts to the index case

One study (N=760){337} found a statistically significant relationship between Mantoux test -positive contacts with no prior risk factors for tuberculosis, and seating proximity to an index patient with MDR TB on an aircraft (RR 8.5, 95%CI 1.7 to 41.3, p=0.01). (**3+**)

Three studies (N=120,{338} N=100,{339} and N=225){336} found no evidence that Mantoux test -positive contacts without prior risk factors for tuberculosis were more likely to be seated in closer proximity to an index case with tuberculosis on an aircraft than Mantoux test -positive contacts with prior risk factors. (**3+**)

12.4.4 From evidence to recommendations

The evidence base for this topic is prone to publication bias, where reports of successful tracing are more likely to be of interest, and therefore the yield of these procedures is likely to be overestimated.

One of the studies{334} had a crew member as an index case and assessed transmission to other crew. This is therefore a workplace study and not directly applicable to passenger-to-passenger transmission.

The evidence base indicates low yield from aircraft-based contact tracing, but proximity to the index case was seen to be a risk factor. However, identifying proximity is costly and difficult. Seating records, or even passenger lists, are not always available, and the onus of contacting passengers lies with the airline. Similar possibilities for transmission arise in other forms of long-haul transport, but seating plans are not generally available in these situations.

'Inform and advise' information is of limited utility in such situations, where risk of infection is extremely low, neither the TB service nor the airline know which passengers are more susceptible to infection, and the passengers receiving such information will not be in contact with a TB service from whom they can seek further advice face to face.

It was therefore felt that it was not an effective use of resources to conduct contact tracing among aircraft passengers or similar transport scenarios, unless a seating plan was available, or where exceptional circumstances exist.

Such exceptional circumstances were identified as including: an index case with MDR TB, frequent coughing, and a flight of over eight hours' duration. The eight hours threshold was recognised as fairly arbitrary, but is drawn from what little evidence exists. It is impossible to define 'frequent coughing' given a subjective assessment which may take place weeks after the flight. Clinical judgement will have to be used in any such case to identify how many passengers to advise the airline to send information to.

Where the index case is a crew member, contact tracing of individual passengers is not necessary as passengers will have had minimal exposure.

12.4.5 RECOMMENDATIONS

R107 Following diagnosis of TB in an aircraft traveller, contact tracing of fellow passengers should not routinely be undertaken.

R108 The notifying clinician should inform the relevant consultant in communicable disease control (CCDC) if: D(GPP)

- less than three months has elapsed since the flight and the flight was longer than eight hours, *and*D(GPP)
- the index case is sputum smear positive, *and*D(GPP)
- the index case has MDR TB, *or*C
- the index case coughed frequently during the flight. D(GPP)

The CCDC should provide the airline with 'inform and advise' information to send to passengers seated in the same part[27] of the aircraft as the index case. D(GPP)

R109 If the TB index case is an aircraft crew member, contact tracing of passengers should not routinely take place. D(GPP)

2006

[27] Published evidence does not allow for a precise definition, but such contact tracing on aircraft has often only included people within three rows on either side of the index case.

R110 If the TB index case is an aircraft crew member, contact tracing of other members of staff is appropriate, in accordance with the usual principles for screening workplace colleagues (see section 12.4). B

Cross-referring:
For details of diagnosing latent TB, see section 5.1.
For details of diagnosing active TB, see section 5.2.
For details of BCG vaccination, see chapter 11.
For details of contact tracing in general, see section 12.2.

12.5 Contact tracing: cases in schools

12.5.1 Clinical introduction

TB in school pupils or staff requires particular attention because of the potential for spread of infection and also because of the anxiety that may arise among pupils, parents, staff and others. They should all be subject to individual risk assessment following discussion with the consultant in communicable disease control.

If the index case of TB is an adult member of staff, the purpose is to detect secondary cases elsewhere in the school, while if it is a pupil, the purpose is not only to detect secondary cases but also to find the source case, if it is not already thought to be known.

12.5.2 Methodological introduction

Studies were included that attempted to establish whether contact tracing was effective in identifying latent and active tuberculosis in school contacts exposed to an index case of tuberculosis in the school setting.

Six cohort studies and four non-analytic studies were found. None of the cohort studies were conducted in the UK, and only one non-analytic study took place in the UK. One cohort study{11} and one non-analytic study{340} were excluded due to methodological limitations, which are presented in Appendix I. Despite limited reporting of participant baseline characteristics, five cohort studies{341–345} and three non-analytic studies{346–348} were included.

2006

12.5.3 Evidence statements

Case yields of latent tuberculous infection

Six studies{341–343},{345},{347},{348} investigated case yields of latent TB infection in school pupils with differing levels of exposure to an index case of sputum smear-positive TB. Latent TB infection yield was reported for the following four exposure categories:

- schools with index cases of TB disease in comparison to control schools with no reported index cases
- school pupils exposed to index cases of TB disease in comparison to pupils with no exposure to index cases
- school pupils with different levels of classroom contact to index cases of TB disease
- school pupils with direct classroom contact to index cases of TB disease in comparison to pupils with no classroom exposure to index cases.

The evidence for latent TB infection is presented in Table 47.

Table 47: Detection of latent TB in schools contact tracing

Exposure category	Context of pupil exposure to TB index cases	Results N (%) pupils Mantoux test+	Association/statistical significance	Study location	Ref and NICE grade
1. Schools with pupil index cases*vs.*control schools	Four secondary schools *vs.* 10 secondary schools	277/3188 (8.7) *vs.* 123/3321 (3.7) [28][29]	$p<10^{-7}$	Italy	{343} 2+
	Two primary schools *vs.* three primary schools	51/722 (7.1) *vs.* 19/702 (2.7) [30]	NS	Canada	{344} 2+
2. Exposed*vs.*no	All current high	120/333 (36) *vs.*	RR 2.3 (95%CI 1.7 to 3.2, p<0.05)	USA	{342} 2+

[28] Tine Test positive
[29] BCG vaccination was discontinued in Italy before the present research cohort were born, so tine test positivity could not be attributed to the booster effect
[30] Prior BCG vaccination and foreign-born status were both significantly associated with Mantoux test positive outcome in all schools.

n- exposed school pupils (pupil index cases)	school pupils *vs.* non-exposed new school entrants	39/248 (16)				2006
	All high school graduates *vs.* non-exposed new school entrants	35/138 (25) *vs.* 39/248 (16)	RR 1.6 (95%CI 1.1 to 2.4, p<0.05)	USA	{342} 2+	
	US-born current high school pupils *vs.* US-born new school entrants	27/145 (19) *vs.* 4/132 (3)	RR 6.1 (95%CI 2.2 to 17.9, p<0.05)	USA	{342} 2+	
	US-born high school graduates *vs.* non-exposed US-born new school entrants	6/66 (9) *vs.* 4/132 (3)	RR 3.0 (95%CI 0.9 to 10.3)	USA	{342} 2+	
3. Different levels of classroom exposure to pupil index cases	Junior high school pupils sharing one plus class *vs.* pupils entering a class recently vacated by index case	95/118 (81) *vs.* 30/88 (34)	Not reported	USA	{345} 2+	
	Junior high school pupils sharing three *vs.* two *vs.*	9/9 (100) *vs.* 32/35 (91) *vs.* 55/74 (74)	Not reported	USA	{345} 2+	

	one class with index case					
	High school pupils sharing	7/13 (54) *vs.*	RR 5.7 (95%CI	USA	{341} 2+	
	three plus *vs.* one plus (normally ventilated) *vs.* one plus (normal or enhanced ventilation) classrooms with index case	21/66 (32) *vs.* 25/106 (24)	3.26 to 10.13) *vs.* RR 4.2 (95%CI 2.6 to 6.75) *vs.* RR 3.2 (95%CI 2.0 to 5.18)			
4a. Pupils with*vs.*pupils without classroom exposure to pupil index cases	High school pupils sharing a classroom *vs.* pupils without classroom exposure	22/110 (20) *vs.* 54/616 (9)	RR 2.3 (95%CI 1.4 to 3.8)	USA	{342} 2+	2006
	Secondary school pupils sharing a classroom *vs.* pupils without classroom exposure	76% tine test positive, nearly 11 times higher than pupils without classroom exposure	RR 10.9 (95%CI 8.7 to 13.4)	Italy	{343} 2+	
	Primary school pupils sharing classrooms *vs.* pupils without classroom exposure	No significant difference in Mantoux test positive rates reported	Not reported	Canada	{344} 2+	
4b. Pupils	Primary	12/28	Not reported	Ireland	{342},{343},{34	

with*vs.*pupils without classroom exposure to teacher index cases	school pupils sharing a classroom *vs.* pupils without classroom exposure	(43) *vs.* 3/27 (11)			7}, {348} 3+

Case yields of active tuberculous disease

Three studies{343},{344},{347},{348} investigated case yields of active TB disease in school pupils with differing levels of exposure to an index case of sputum smear-positive TB. Active disease in contacts was variably defined as

- abnormal chest X-ray{342},{343},{347},{348}
- not specified by test result or site of disease{344}
- presence/absence of positive AFB sputum smear or X-ray findings compatible with cavitary disease.{343}

Active TB disease case yield was reported for the following two exposure categories:

- schools with index cases of TB disease in comparison to control schools with no reported index cases
- school pupils exposed to index cases of TB disease in comparison to pupils with no exposure to index cases.

The evidence for active TB disease is presented in Table 48.

Table 48: Summary of evidence: detection of active TB in schools contact tracing

Exposure category	Context of pupil exposure to TB index cases	Results N (%) pupils with TB disease	Statistical significance	Study location	Ref and NICE grade
Schools with index cases*vs.*control schools	Four secondary schools *vs.* 10 secondary schools	14/3188 (0.4) *vs.* 1/3321 (0.03)	Not reported	Italy	{343} 2+
	Two primary schools *vs.*	1/722 (0.1) *vs.* 0/702	Not reported	Canada	{344} 2+

2006

	three primary schools				
Pupils with*vs.*pupils without classroom exposure to teacher index cases	Primary school pupils sharing a classroom *vs.* pupils without classroom exposure	8/28 (29) *vs.* 0/27	Not reported	Ireland	{342},{343},{347},{348} 3+

Case yields for a general TB outcome

One study conducted in the UK{342},{343},{347},{348} reported a general TB outcome (combined latent TB infection and active TB disease yield) for primary schools pupils with *vs.* those without classroom exposure to a teacher with sputum smear- and culture-positive tuberculous disease who developed symptoms over a three-month period prior to the outbreak.

31/46 (67%) pupils from two classrooms shared with the index case *vs.* 15/46 (33%) pupils from five non-exposed classrooms were diagnosed with TB infection or disease. No statistical significance testing was reported. (**3+**)

Transmission of tuberculosis disease from an index case to exposed school contacts verified by DNA fingerprint analysis

A study conducted in New Zealand{346} found that cases of active tuberculosis identified by contact tracing in secondary school pupils were confirmed by DNA fingerprint analysis to be due to direct transmission from school index cases. (**3+**)

12.5.4 From evidence to recommendations

There are the following potential difficulties in making recommendations from the evidence base.

- There is a possibility of publication bias in the evidence base, where reports of successful tracing are more likely to be of interest, and therefore the yield of these procedures is likely to be overestimated.

- The evidence base does not take into account the country of birth or ethnicity of pupils, which is likely to be a confounding factor. In schools with a large proportion of pupils drawn from populations with high rates of TB, latent

infection and active disease in some of those screened might erroneously be concluded as being due to transmission from the index case.

- Many of the studies conducted outside the UK were carried out in non-BCG vaccinated populations.
- Rates of disease are calculated on small denominators and are therefore imprecise.

The aim of contact tracing is different across age groups. In younger children a source is being sought, while in adolescents and adult staff members contact tracing is usually (but not invariably) the sole reason for the exercise.

The GDG were keen to limit the resources that might be consumed by these large and mainly unproductive exercises, and agreed that initially, only children in the same class as the index case need to be assessed. School registers may help in identifying the pupils at highest risk.

After-school, sports and religious activities should also be kept in mind where the degree of contact might be equivalent to classroom contact. The GDG agreed that outdoor activities would not normally pose a risk of TB transmission, unless this involved confined spaces for prolonged time periods, for example camping. Such obvious exceptions were not felt to require a recommendation.

12.5.5 RECOMMENDATIONS

R111 Following diagnosis of TB in a school pupil or member of staff, the CCDC should be prepared to explain the prevention and control procedures to staff, parents and the press. Advice on managing these incidents and their public relations is available from the HPU. D(GPP)

R112 If a school pupil is diagnosed with sputum smear-positive TB, the rest of his or her class (if there is a single class group), or the rest of the year group who share classes, should be assessed as part of contact tracing. B

R113 If a teacher has sputum-smear-positive TB, the pupils in his or her classes during the preceding three months should be assessed as part of contact tracing. C

R114 Clinicians conducting contact tracing in a school should consider extending it to include children and teachers involved in extracurricular activities, and non-teaching staff, on the basis of: D(GPP)

- the degree of infectivity of the index case
- the length of time the index case was in contact with others
- whether contacts are unusually susceptible to infection
- the proximity of contact.

R115 Secondary cases of sputum smear-positive TB should be treated as index cases for contact tracing (see R111–R114 above for class of recommendation).

R116 If the index case of a school pupil's TB infection is not found, and the child is not in a high-risk group for TB, contact tracing and screening (by either symptom enquiry or chest X-ray) should be considered for all relevant members of staff at the school. D(GPP)

Cross-referring:
For details of diagnosing latent TB, see section 5.1.
For details of diagnosing active TB, see section 5.2.
For details of BCG vaccination, see section 11.6.
For details of contact tracing in general, see section 12.2.
If smear-positive TB is diagnosed in an adult working in community childcare, see section 12.6.
For examples of 'inform and advise' information, see Appendix H.

12.6 Contact tracing: community childcare

12.6.1 Clinical introduction

Children, particularly of pre-school age, are more likely to acquire TB infection, and progress to TB disease, than older children and adults if they are exposed to infectious tuberculosis –usually from adults. Each year in England and Wales there are a number of incidents where children in nurseries and other childcare facilities are screened for tuberculosis after exposure to an adult staff member. Government policy and social changes mean that more children will be found in childcare

settings. An increasing number of adults will therefore be in contact with children up to age 16 years.

12.6.2 Methodological introduction

Studies investigating whether there were specific management strategies that were effective in preventing and controlling the transmission of TB infection and disease in childcare settings were sought. One cohort study was found that addressed the question.

The study, conducted in a hospital nursery setting in the USA{349} focused on screening for tuberculosis in infants and healthcare workers exposed to an index case of TB disease. Selection of infants to different TB screening procedures was based on level of TB exposure. Mantoux test conversion rates in healthcare workers who worked in the nursery unit when the index case was present were compared with healthcare workers in the hospital who had not worked in the unit.

12.6.3 Evidence statements

Latent TB infection in infants and healthcare workers with high versus low risk of exposure to an index case of TB

No difference between high and low exposure groups in the number of tuberculin-positive reactions was identified.{349} The evidence is summarised in Table 49.

Table 49: Summary of evidence: detection of latent TB in community childcare

Patient group and exposure status	N (%) Mantoux test positive reactors in participants with low exposure to the index case	N (%) Mantoux test positive reactors in participants with high exposure to the index case	Statistical significance	NICE grade
Infants				
Low/high exposure shared unit with index case 8–12/0–8 weeks prior to diagnosis	1/259 (7 mm reaction at age 11 weeks, received BCG vaccination at age three days)	0/139 (including 30 aged more than 56 days)	Not reported	2+
Healthcare workers				
Low/high exposure never worked in unit/worked in unit during index case stay	14/619 (2.26) converted	4/130 (3.08) converted	NS p<0.6	2+

Completion rate for isoniazid prophylaxis among high-exposure infants
132/139 (95%) infants with high exposure to an index case of TB disease completed a three month course of isoniazid prophylaxis.{349} (**2+**)

12.6.4 From evidence to recommendations

There is no relevant evidence on which to base recommendations. Because of the lack of an infrastructure to provide screening for this very diverse setting, which includes informal care arrangements, recommendations deal only with contact tracing.

12.6.5 RECOMMENDATION

R117 When an adult who works in childcare (including people who provide childcare informally) is diagnosed with sputum smear-positive TB, management is as for contact tracing (see section 12.2). D(GPP)

12.7 Contact tracing: cases in hospital inpatients

12.7.1 Clinical introduction

With the increasing numbers of clinical cases of tuberculosis, some of whom are admitted to hospital, there are incidents where patients with tuberculosis are not appropriately isolated, leading to potential exposure of other patients, some of whom may have reduced immunity. Such incidents are not strictly outbreaks, but may consume considerable resources identifying exposed patients, many of whom are at minimal risk.

A further type of incident is where a healthcare worker is found to have active tuberculosis, with patients being exposed to possible infection risks. This latter type of incident often involves staff recruited from overseas, who may only have been screened to healthcare worker level and not to the higher level advised for new entrants from high-incidence settings (see section 12.1).

Finally, there have been true outbreaks where patients, usually but not exclusively HIV co-infected, have acquired active tuberculosis disease from other inpatients, often due to failure to use appropriate infection control measures, or because facilities thought to be negative pressure were not actually so.{232} Such outbreaks,

particularly when of MDR TB transmission, can have a high mortality and morbidity, as well as major medicolegal implications for NHS trusts.{232}

12.7.2 Methodological introduction

Studies that investigated whether contact tracing was effective in identifying latent tuberculosis infection and active tuberculosis disease in patient and staff contacts exposed to an index case of tuberculosis in the hospital setting were targeted.

One case control study and four non-analytic studies were identified. The case control study from the USA{350} evaluated a contact tracing investigation of hospital staff conducted in relation to an index patient diagnosed with tuberculosis disease from an extrapulmonary site. Despite limited reporting of baseline characteristics, and no significance testing for the outcome of Mantoux test converters in exposed cases and non-exposed controls, the study was included. Two non-analytic studies from the UK{351} and the USA{352} were included.

Three non-analytic studies from the USA{353} and the UK{232},{354} were excluded due to methodological limitations, which are presented in Appendix I.

12.7.3 Evidence statements

Case yields of latent tuberculous infection

Two studies{350},{352} investigated latent TB infection in staff with different levels of exposure to index cases of active TB disease in hospital settings. Neither of the studies was conducted in the UK.

The evidence for latent TB infection is presented in Table 50.

Table 50: Detection of latent TB in contact tracing among health care workers (HCWs)

Exposure category	Exposure content	Results Healthcare workers with Mantoux test conversions, N (%)	Association/statistical significance	Ref and NICE grade
Exposed*vs.*non-exposed healthcare workers (non-pulmonary patient index	Nurses exposed to index case after surgery *vs.* nurses and students	12/95 (13) *vs.* 2/1435 (0.14) *vs.* 0/23	Not reported	{350} 2+

case)	exposed prior to surgery *vs.* non-exposed historical control nurses			
Exposed*vs.*non-exposed healthcare workers (healthcare workers index case)	Healthcare workers on two wards (A and B) *vs.* healthcare workers on non-exposed wards	Ward A 21/70 (30) *vs.* 10/76 (13.2) non-exposed wards	RR 2.3 (95%CI 1.2 to 4.5, p=0.02)	{352} 3+
		Ward B 29/61 (47.5) *vs.* 10/76 (13.2) non-exposed wards	RR 3.6 (95%CI 1.9 to 6.8, p<0.001)	{352} 3+
		Controlling for exposure to infectious TB patients (N=25): risk of Mantoux test conversion remained higher for healthcare workers on wards A and B	Weighted RR 3.0 (95%CI 1.9 to 4.5, p<0.001)	{352} 3+

2006

Case yields of active tuberculous disease

Two studies{351},{352} investigated case yields of active TB disease in patients and staff in hospitals where index cases of active TB disease had been identified. One of the studies was conducted in the UK. Active TB disease case yields were reported for the following:

- staff with and without exposure to TB index cases
- hospital staff, surgical patients and renal patients exposed to a TB index case.

The evidence for active TB disease is presented in Table 51 below.

Table 51: Detection of active TB in contact tracing among healthcare workers

Population	Exposure to healthcare workers index cases	Results Healthcare workers with TB disease, N (%)	Statistical significance	Ref and NICE grade
Exposed*vs.*non-exposed healthcare workers	HCWs exposed on two wards (A and B) *vs.* Healthcare	8/51 (16) wards A and B *vs.* 0/76 non-exposed wards	Not reported	{352} 3+

	workers on non-exposed wards			
Healthcare workers*vs.*renal patients*vs.*surgical patients	All groups exposed in a hospital	0/135 *vs.* 1/220 (0.45%) *vs.* 0/57	Not reported	{351} 3+

Type of exposure to the index case

One study{350} found that exposure to the surgical wounds of an index case of non-pulmonary TB was significantly associated with latent TB among previously Mantoux test -negative nurses.

Irrigation or packing of the wound was the only statistically significant risk factor for a positive Mantoux test (OR 9, 95%CI 1.2 to 67, p=0.03), with nurses involved in these activities having nine times the risk of Mantoux test conversion compared to nurses not involved in substantial wound care. (**2+**)

Duration of exposure

Hospital staff Mantoux test converters and index cases worked more total shifts on two wards with infectious TB cases than staff who were Mantoux test negative (Ward A median 80 *vs*. four shifts, p=0.004; Ward B median 124 *vs.* five shifts, p<0.001).{352} (**3+**)

12.7.4 From evidence to recommendations

The wide variety of settings and possibilities mean that narrowly drawn guidelines are not appropriate. The pick-up from contact tracing exercises is very low so it is important to avoid unnecessary screening. Evidence from North America may show levels of potential transmission, but is not particularly relevant for the effectiveness of service models in the UK. The GDG's considerations were otherwise constrained by the paucity of evidence relevant to the UK.

Awareness of tuberculosis and transmission risks needs to be maintained in healthcare workers who work with immunocompromised patients – for example surgeons who work with transplant patients, and oncologists. A rigorous risk assessment was regarded as useful before any action is taken.

The GDG recognised the need to limit contact tracing exercises to instances where there is a genuine risk of TB transmission, and chose eight hours as a time

threshold for exposure. There is no evidence to support this, but it is in line with the threshold given elsewhere for contact tracing.

12.7.5 RECOMMENDATIONS

R118 Following diagnosis of TB in a hospital inpatient, a risk assessment should be undertaken. This should take in to account:

- the degree of infectivity of the index case
- the length of time before the infectious patient was isolated
- whether other patients are unusually susceptible to infection
- the proximity of contact.

Contact tracing and testing should be carried out only for patients for whom the risk is regarded as significant. D(GPP)

R119 Patients should be regarded as at risk of infection if they spent more than eight hours in the same bay as an inpatient with sputum smear-positive TB who had a cough. The risk should be documented in the contact's clinical notes, for the attention of the contact's consultant. The contact should be given 'inform and advise' information, and their general practitioner should be informed. D(GPP)

R120 If patients were exposed to a patient with sputum smear-positive TB for long enough to be equivalent to household contacts (as determined by the risk assessment), or an exposed patient is known to be particularly susceptible to infection, they should be managed as equivalent to household contacts (see section 12.2). D(GPP)

R121 If an inpatient with sputum smear-positive TB is found to have MDR TB, or if exposed patients are HIV positive, contact tracing should be in line with the Interdepartmental Working Group on Tuberculosis guidelines.{386}D(GPP)

R122 In cases of doubt when planning contact tracing after diagnosing sputum-smear-positive TB in an inpatient, further advice should be sought from the regional or national Health Protection Agency or people experienced in the field. D(GPP)

Cross-referring:
For details of diagnosing latent TB, see section 5.1.

For details of diagnosing active TB, see section 5.2.

For details of BCG vaccination, see section 11.6.

For details of contact tracing in general, see section 12.2.

For examples of 'inform and advise' information, see Appendix H.

12.8 New entrants screening (people recently arriving in or returning to the UK)

12.8.1 Clinical introduction

The five-yearly national notification surveys have consistently shown the highest rates of clinical tuberculosis disease in recent arrivals, particularly within the first few years after initial entry. This trend has been shown from 1978/9{355} through to 1998,{26} and in continuous enhanced surveillance from 1999–2002,{140} with 63% of all cases in 2001 being non-UK born. From 1978/9 to 1988 the great majority of people other than of white ethnicity with TB were of Indian subcontinent origin, but from 1988 onwards there has been a significant increase in the proportion of cases of black African origin, from 1.7% in 1988 to 13% in 1998, and most recently 21% in 2002.

Deficiencies in the official port of arrival system were recognised in these documents, with advice that local systems and information be used to augment new entrant identification. Screening for new entrants from settings of high incidence (defined as those with an incidence rate of at least 40/100,000) was advised. In practice this applied to all new entrants apart from those from the then European Union countries, Australia, New Zealand, Canada and the USA.{6}

Following identification of appropriate new entrants, the tools available for screening were the same as those for household contacts of cases of tuberculosis: enquiry about symptoms of (and any prior history of) tuberculosis, BCG history corroborated by documentation or scar, tuberculin skin testing and chest X-ray.{6} Interferon-gamma immunological tests were not available in the UK in the 1990s.

12.8.2 Current practice

The review of current services found that, where new entrants services were provided, it could be via a dedicated new entrants service, often a primary care-

based, holistic new entrants programme. Otherwise, new entrants may be seen in general TB clinics. Some clinics did not appear to have any provision for new entrant screening. The review did not cover the newer arrangements in fast-track induction centres for refugees, which are organised by the Home Office.

Outside London, 44% of service providers had a dedicated new entrant clinic and 35% saw new entrants in a general clinic, usually the BCG clinic. For two local services (3%), new entrants were seen at home. Other respondents had no specific new entrant screening programme. Within London, 55% had a dedicated clinic.

12.8.3 Methodological introduction

Studies that compared different service models of TB screening for new immigrants in order to evaluate which was most effective were targeted.

Two cohort studies from the UK{297},{356} and one cohort from the Netherlands{357} were found. None of the studies reported whether blinding of the investigators to the different service models being evaluated had taken place. Two studies, one from the UK{296} and one conducted in Italy,{358} were excluded due to additional methodological limitations listed in Appendix I.

In addition, there was a search for studies that compared different screening methods for latent and active tuberculosis in new immigrants and ethnic minority residents returning from settings with a high incidence of TB to evaluate which was most effective.

Three non-analytic studies were identified. One study{359} focused on symptom questionnaire and chest X-ray screening methods applied to a group of East Timor refugees screened on entry into Australia. A second study{360} examined the sensitivity of Mantoux test and chest X-ray for a subsequent diagnosis of active TB in Tibetan refugees entering the USA. A third study conducted in the USA{361} was excluded due to methodological limitations presented in Appendix I.

12.8.4 Evidence statements: service models

Proportions of new immigrants identified by different service models

Two studies{297},{356} compared the proportions of new immigrants screened for TB by different service models within the same area. Service models included:

- port of arrival identification
- primary care (GP or family practitioner) identification
- targeted screening of the homeless.

The evidence for the proportions of new entrants identified by the different models is presented in Table 52.

Table 52: Summary of evidence: models of new entrant screening

POA model, N (%) screened	Primary care model, N (%) screened	Homeless screening model, N (%) screened	Statistical significance	Ref and NICE grade
199 (48)	45 (11) – GPs	172 (41) – targeted screening	Not reported	{297},{356} 2+
905 (53)	787 (47) – family practitioner committee model	Not done	Not reported	{297},{356} 2+
4/103 (3.8) homeless new immigrants arriving in UK in previous two years	N/A	103/172 arrived in the UK in the previous two years	Not reported	{297},{356} 2+

Proportions of new immigrants identified with latent tuberculosis

In one study{356} the POA service model identified more new immigrants with weak tuberculin-positive reactions, but fewer with strongly positive Mantoux test reactions in comparison to targeted screening of homeless new immigrants and new immigrants screened in GP settings. The evidence is presented in Table 53.

Table 53: Detection of latent TB in contact tracing among new entrants

POA model, N (%) Heaf tested, Heaf grade	Primary care model, N (%) Heaf tested, Heaf grade	Homeless screening model, N (%) Heaf tested, Heaf grade	Statistical significance	NICE grade
100/181 (55) grade 2	14/39 (35) grade 2	84/172 (49) grade 2	Not reported	2+
9/181 (5) grade 3 or 4	8/39 (21) grade 3 or 4	13/172 (8) grade 3 or 4	Not reported	2+

Proportions of new immigrants identified with active tuberculosis

Two studies{356},{297} focused on comparing the proportions of new immigrants with active TB disease identified by different service models within the same area. Service models were:

- port of arrival identification
- primary care (GP or family practitioner) identification
- targeted screening of the homeless
- passive case finding.

The evidence is presented in Tables 54 and 55 below.

Table 54: Detection of latent TB in contact tracing among new entrants

Port of arrival model, N (%)	Primary care model, N (%)	Homeless screening model, N (%)	Statistical significance	Ref and NICE grade
3/181 (2)	0/39	0/172	Not reported	{297} 2+

Table 55: Detection of active TB disease in new entrants detected within the same five-year time period, N (%)

Port of arrival and primary care models combined	Primary case finding model	Statistical significance	Ref and NICE grade
11/57 (19)	27/57 (47.3)	Not reported	{356} 2+

Comparing hospital admissions and duration of symptoms in TB disease cases identified by new immigrant screening and passive case finding

One study{357} found that active TB cases detected by new immigrant screening had on average shorter duration of symptoms and fewer hospital admissions compared to TB patients detected by passive case finding. The evidence is presented Table 56.

Table 56: Symptoms and hospital admissions in new entrants identified with active TB

Outcome	New immigrant screening	Passive case finding	Association/statistical significance	NICE grade
Mean (median) duration of symptoms, all TB cases	4.2 (0) weeks	10.5 (7.5) weeks	p<0.001	2+
Mean (median) duration of symptoms, smear-positive cases only	4.2 (0) weeks	11.4 (6) weeks	p<0.001	2+
Mean (median) duration of symptoms,	4.6 (0) weeks	10.5 (8) weeks	p<0.001	2+

TB cases resident six plus months				
Hospital admissions, N (%)	91/446 (20) admitted	215/361 (60) admitted	OR 0.2 (95% CI 0.1 to 0.2)	2+

12.8.5 Evidence statements: screening methods

Effectiveness of symptom questionnaire in comparison to chest X-ray for predicting a diagnosis of active tuberculosis

One study from Australia{359} found that a symptom questionnaire was less accurate in predicting cases of active tuberculosis in East Timor refugees compared to chest X-ray.

Chest X-ray suggestive of TB was the only statistically significant predictor of a diagnosis of TB, with 95.8% of those diagnosed with TB having an abnormal chest X-ray (OR 2.76, 95%CI 1.25 to 6.07, p= 0.01). (**3+**)

Effectiveness of Mantoux tests in comparison to chest X-ray for predicting a diagnosis of active tuberculosis

One study from the USA{360} found that chest X-ray was significantly associated with cases of active TB in Tibetan refugees whereas the size of Mantoux test induration in the sample was not.

Chest X-ray abnormalities were associated with an increased risk of subsequent diagnosis of active TB (RR 6.78, p=0.005). (**3+**)

12.8.6 Health economic modelling

A decision analytic model was used to estimate the cost-effectiveness of alternative screening algorithms for new entrants from high-risk countries. The economic model was based on an initial algorithm which included initial screening for active disease using a symptom checklist with clinic follow-up for suspected cases, and skin testing for detecting latent infection in new entrants aged 35 or younger. It was assumed that prophylaxis would be offered to those with positive skin tests, and no active disease, and that BCG vaccination would be offered to people with a negative skin test and no evidence of prior BCG. The model included assumptions about the attendance and treatment concordance rates. We then estimated the cost-effectiveness of variations to the screening algorithm, and the overall cost-effectiveness of the algorithm as a function of the prevalence of active and latent TB

in the cohort, and the future incidence for people with/without latent infection at the time of screening.

The model used a simple decision tree approach, assuming a fixed number of secondary cases per primary case, rather than modelling the dynamics of transmission within the population. The results should thus be treated with caution. Caution is also required because of considerable uncertainty over various data inputs and assumptions, and also because of likely variation in programme effectiveness and costs in different areas. As far as possible, the model was based on best available empirical evidence. However, no data were available for some key parameters, so judgement from GDG members was used to estimate likely ranges of values.

It is important to recognise that the model does not take account of other potential benefits of screening – for example, community-based screening may act to introduce new entrants to local health services, and as a screen for other possible health problems. The model also does not take account of other ways in which screening and treatments could be better targeted. For example, the decision to offer prophylaxis could be informed by individuals' likely exposure to TB, risk factors for developing active TB, and/or evidence of latent infection from X-ray.

12.8.7 Cost-effectiveness of prophylaxis for suspected latent infection

The economic model suggests that prophylaxis is not cost-effective in the context of new entrant screening. Using the base case assumptions, the estimated incremental cost per QALY gained for including prophylaxis in the new entrant screening algorithm was nearly £400,000. This result was robust to variation in the model parameters.

Cost-effectiveness of BCG for Mantoux test -negative new entrants

The model predicts that BCG vaccination is cost-saving for the NHS in the context of new entrant screening. Removing vaccination for Mantoux test -negative new entrants from the new entrant screening algorithm would lead to a cost increase of £20,000 and a QALY loss of 1.8 per 100,000 screened, under the base case assumptions.

Symptom checklist vs. chest X-ray for detecting active disease

The cost-effectiveness of initial screening for active disease with a symptom checklist compared with chest X-ray depends on their relative costs and accuracies. Under the base case assumptions, the model suggests that although X-ray screening is more expensive, it leads to an overall saving in NHS expenditure due the lower number of false positive results that is predicted.

Interferon-gamma test vs. tuberculin skin test for latent infection

The model suggests that, despite its higher initial cost, interferon-gamma testing might be a cost-effective alternative to skin testing if it is demonstrated to give a lower number of false positive results. Under the base case assumptions, the model predicted that IGTs would be cost-saving in comparison with skin tests.

Cost-effectiveness of new entrant screening

At low levels of prevalent TB in the cohort tested, none of the screening algorithms was cost-effective. The algorithm without prophylaxis achieves an ICER of £30,000 per QALY at a TB prevalence of about 3%, and an ICER of £20,000 per QALY at about 4% prevalence. This is relatively high compared with rates of disease found in many new entrant screening programmes.

12.8.8 From evidence to recommendations

Current political policy aims for increasing use of chest X-ray screening for active TB prior to entry to the UK. This excludes children under 11 and women who might be pregnant. This NICE guideline addresses activities in the NHS, ie after arrival, and does not address services provided at the port of arrival or in induction centres for asylum seekers. However, the first consideration in screening is whether or not this pre-entry X-ray has been carried out and results are available. Readers are advised to check for new developments in these policies when interpreting the recommendations below.

The GDG were mindful of the legal restrictions on access to NHS services for overseas visitors, and the difficulty this introduces for screening. The data on comparisons of methods of screening is weak and does not show a clear best method. The GDG is aware of the rapidly developing field of interferon-gamma

testing for latent TB. Insufficient data is currently available on its utility in this setting to recommend its routine use at this stage.

National surveys up to 1998 and continuous enhanced surveillance since 1999 show the highest rates of TB in new arrivals. Some cases are found by X-ray screening at port of arrival, and some by new-entrant screening soon after arrival, but most cases arise at least one year after initial entry to the UK (see Appendix G for details).

The purpose of screening high-risk groups, such as arrivals from high-incidence settings (defined as an incidence of 40 cases/100,000 per annum), and all asylum seekers, is threefold.

1. To detect cases with active disease, particularly respiratory, to enable treatment to be given, and prevent secondary cases.

2. To detect those with tuberculosis infection, particularly children, for whom treatment for latent TB infection is appropriate.

3. To identify those with no evidence of tuberculosis infection who, if previously unvaccinated, may benefit from BCG vaccination.

The health economics in this area clearly indicate that targeting screening activities on the new entrants at highest risk of developing active TB is crucial if the screening is to be cost-effective to the NHS. However, the data are very limited and further economic research is needed to support policy in this area. The epidemiology shows that most cases of active TB in new entrants develop some time after arrival in the UK. There are also policy changes under way in terms of pre-entry screening for active TB. The GDG drafted the algorithm shown below to reflect their consensus on screening new entrants.

The process of identifying new entrants for screening through port of arrival notification to the local CCDC has limitations, and the recommendations therefore advise on different sources which can be used. This is relevant to conditions other than TB, but is not currently practised uniformly around the country, and therefore is specified here.

12.8.9 RECOMMENDATIONS

R123 Healthcare professionals, including primary care staff, responsible for screening new entrants[31] should maintain a coordinated programme to:

- detect active TB and start treatment B
- detect latent TB and start treatment B
- provide BCG vaccination to those in high-risk groups who are not infected and who are previously unvaccinated D(GPP)
- provide relevant information to all new entrants. D(GPP)

R124 New entrant screening for tuberculosis should be incorporated within larger health screening programmes for new entrants, linked to local services. D(GPP)

R125 Assessment for, and management of TB in new entrants should consist of the following. D(GPP). See also R5 for assessment of latent TB

- Risk assessment for HIV, including HIV prevalence rates in the country of origin, which is then taken into account for Mantoux testing and BCG vaccination.
- Assessment for active TB if interferon-gamma test is positive, which would include a chest X-ray.
- Treatment for latent TB infection for people aged 35 or younger in whom active TB has been excluded, with a positive Mantoux test inconsistent with their BCG history, and a positive interferon-gamma test.
- Consideration of BCG for unvaccinated people who are Mantoux negative (see section 11.4).
- 'Inform and advise' information for people who do not have active TB and are not being offered BCG or treatment for latent TB infection.

See the algorithm in Figure 12 for further detail.

2006

2006, amended 2011

[31] In this guideline, new entrants are defined as people who have recently arrived in or returned to the UK from high-incidence countries, as defined by the HPA; go to **www.hpa.org.uk** and search for 'WHO country data TB'.

R126 New entrants should be identified for TB screening from the following information:

- port of arrival reports D(GPP)
- new registrations with primary care B
- entry to education (including universities) D(GPP)
- links with statutory and voluntary groups working with new entrants. D(GPP)

R127 Any healthcare professional working with new entrants should encourage them to register with a GP. D(GPP)

Cross-referring:

For details of diagnosing latent TB, see section 5.1.

For details of diagnosing active TB, see section 5.2.

For details of BCG vaccination, see section 11.4

For examples of 'inform and advise' information, see Appendix H.

This algorithm is currently being reviewed and has been temporarily removed.

12.9 Street homeless people

12.9.1 Clinical introduction

Deprivation has long been associated with tuberculosis. Much higher rates of tuberculosis disease in street homeless people and hostel dwellers have been recognised for many years{362},{363}. Chest X-ray screening of homeless people attending a soup kitchen in London in 1993{364} showed 4.3% with X-ray changes suspicious of active tuberculosis of which 1.5% (1,500/100,000) were confirmed as having bacteriologically confirmed active disease. The great majority of such street homeless people in the UK up to the late 1990s were men of white ethnicity, whose rate of tuberculosis from national data would normally be expected to be in the range of 5/100,000 per annum.{26},{140}

12.9.2 Methodological introduction

Studies that compared different methods of screening for latent tuberculosis infection and active tuberculosis disease in homeless people in order to evaluate which method was most effective were targeted.

Six non-analytic studies focused on different tuberculosis screening methods applied to homeless participants. None of the studies reported the results of interferon-gamma immunological testing in homeless people. Four studies{308},{328},{365},{366} did not make comparisons between the different screening methods they reported and were excluded.

Two studies{367},{368} conducted in the UK and the USA compared homeless people diagnosed with active tuberculosis with their prior test results on symptom questionnaire, tuberculin skin test, and chest X-ray. The studies were included despite having the following methodological limitations.

- The number of people approached for screening and resultant screening uptake was not clearly reported.
- Not all tests were read and no explanation for this was provided.
- Some studies offered incentives to attend for screening, while others did not.
- Those involved in collecting prospective data via interviews were aware of retrospective findings that categorised subjects by clinical outcome.

- It was not reported how screening tests were conducted and read and by whom.
- Screening methods used did not show a combination of good sensitivity and specificity.
- Uptake of screening varied between 40–90% at different sites.
- Investigators did not state whether tests were performed blindly or independently.
- Statistical significance testing was not done.

12.9.3 Evidence statements

Comparative effectiveness of symptom questionnaire, tuberculin skin test and chest X-ray for detecting latent tuberculous infection

One retrospective study{367} found that tuberculin skin testing was more effective in detecting latent tuberculosis and eligibility for treatment for latent TB infection in homeless people than either symptom questionnaire or chest X-ray. The evidence is presented in Table 57.

Table 57: Summary of evidence: detection methods for latent TB

People with abnormal symptom questionnaire scores	People with positive tuberculin skin test results, Heaf grade 4	People with abnormal chest X-ray results	Statistical significance	NICE grade
0/5 with Heaf grade 4 (0% sensitivity)	5/5 prescribed treatment for latent TB infection (100% sensitivity)	0/5 with Heaf grade 4 (0% sensitivity)	Not reported	3+

Comparative effectiveness of symptom questionnaire, tuberculin skin test and chest X-ray for detecting active tuberculous disease

Two retrospective studies,{367},{368} did not find consistent evidence that any of the three screening methods compared were more effective than the others in detecting signs and symptoms of TB in homeless people subsequently diagnosed with active tuberculosis. Evidence is summarised in Table 58 below.

Table 58: Summary of evidence: detection methods for active TB

N (%) TB disease cases with abnormal symptom questionnaire scores	N (%) TB disease cases with tuberculin skin test positive scores	N (%) TB disease cases with abnormal chest X-ray results	Statistical significance	Ref and NICE grade
2/10 (20) reported	1/10 (10) (7/10	8/10 (80)	Not reported	{367},{368}

haemoptysis	cases did not have Mantoux test)			3+
13/16 (81), sensitivity 81%, specificity 51%, PPV 23%, NPV 94%	11/16 (69), sensitivity 69%, specificity 83%, PPV 42%, NPV 94%	5/16 (31), sensitivity 31%, specificity 94%, PPV 50%, NPV 88%	Not reported	{367};{368} 3+
PPV = Positive predictive value; NPV = Negative predictive value.				

12.9.4 From evidence to recommendations

The rate of TB in street homeless people is still high. This group is difficult to reach. Emphasis should therefore be on active case finding, which may have to be done on an opportunist and/or symptomatic basis. In urban settings, digital chest X-ray provides fast results for likely active disease.

Simple incentives for attending screening, such as hot drinks or snacks, may be useful. Because of the mobility of this group, tuberculin skin testing and interferon-gamma testing were felt to be less useful generally, because people may move before test reading and are also not likely to complete treatment for latent TB infection. The important role of the TB service was recognised in promoting awareness of TB, and who to contact, among those working with homeless people, including primary care professionals, and the social and voluntary sectors.

The GDG were unable to make a service configuration recommendation on the frequency of screening in this group, given the lack of any evidence to guide them.

12.9.5 RECOMMENDATIONS

R128 Active case finding should be carried out among street homeless people (including those using direct access hostels for the homeless) by chest X-ray screening on an opportunistic and/or symptomatic basis. Simple incentives for attending, such as hot drinks and snacks, should be considered. D(GPP)

R129 Healthcare professionals working with people with TB should reinforce and update education about TB, and referral pathways, to primary care colleagues, social workers and voluntary workers who work with homeless people. D(GPP)

Cross-referring:
For details of diagnosing active TB, see section 5.2.

13 Preventing infection in specific settings

13.1 Healthcare environments: new employees

13.1.1 Clinical introduction

Studies in the late 1980s suggested that the incidence of TB in healthcare workers, with the general exception of mortuary workers, was no higher than that of the general population.{369} More recently however a study found a twofold increased risk among healthcare workers.{300} Also more recently the NHS has been recruiting staff, particularly nurses, from developing countries with a high incidence of tuberculosis. This is acknowledged as an essential area for improvement in the 2004 Chief Medical Officer's TB Action Plan{2} which gives as a goal: 'achieve comprehensive occupational screening of healthcare workers joining the NHS'.

13.1.2 Methodological introduction

Studies on the prevention of TB transmission in newly employed staff in hospital settings were sought. Only one non-analytic study{370} met the inclusion criteria.

Studies focusing on pre-employment screening measures to prevent and control the transmission of TB in healthcare workers with HIV infection were also targeted. No evidence was found, and hence there are no evidence statements for this area.

13.1.3 Evidence statements

TB prevention and control measures in pre-employment occupational health screening

One retrospective non-analytic study{370} reported on the following interventions for pre-employment occupational health screening in West Midlands NHS hospitals:

- identification of new doctors eligible for TB screening
- identification of new doctors and nurses at risk for active tuberculous disease
- appropriateness of tuberculin skin testing for new employees.

Evidence is summarised in Table 59.

Table 59: Summary of evidence: pre-employment screening

Intervention	Occupational health service pre-employment screening	NICE grade

Doctors eligible for TB screening, N (%)	Identified 7/14 (50) new doctors who developed active TB disease during employment.	3+
Healthcare workers at risk for active TB disease, measured by Heaf test grade	• Did not act on evidence of TB transmission in newly appointed doctors, and found no evidence of TB transmission in newly- appointed nurses. • 3/7 new doctors Mantoux test positive (grades 3–4) subsequently diagnosed with active TB via self-referral with symptoms. • Six new nurses Mantoux test negative (grades range 0–2) subsequently diagnosed with active TB.	3+
Mantoux test, Heaf test	• Inappropriately applied Mantoux tests to 13/26 new employees. • Two without prior BCG vaccination were not tested and developed TB disease. • Nine with prior BCG vaccination were tested. • 1/2 with unknown BCG status was tested.	3+

13.1.4 From evidence to recommendations

This guideline is not intended to duplicate the guidance which was, at the time of writing, being drafted by the Department of Health ('Health clearance for serious communicable diseases: new health care workers').

The recommendations are also guided by the advice of the Chief Medical Officer to the NHS in England to 'achieve comprehensive occupational screening of healthcare workers joining the NHS'.{2}

There is a possibility that new employees in healthcare environments who have recently entered the UK can miss out on the advanced level of screening given to new entrants. In this regard, the recommendations refer the reader to the section of the guideline for new entrants.

Limitations in pre-employment screening techniques are reported in the evidence base. Consequently, the GDG agreed that symptoms should be screened first, possibly by questionnaire, as a way to identify any new staff who may have active tuberculosis. Chest X-rays are the first choice of test for those with signs or symptoms.

For the majority of new employees without any signs or symptoms, resources should be used effectively by carrying out an individual risk assessment and choosing screening techniques accordingly. This is familiar current practice for many occupational medicine departments.

The recommendations aim to make sure that new employees are screened before commencing work. It was noted that the NICE guideline cannot dictate screening techniques to non-NHS agencies, and also that such screening may be carried out in other countries with attendant difficulty in receiving documentation. However, the health risks associated with employing an infectious member of staff were deemed to warrant a thorough check before they start work.

The evidence base does not support a significant departure from the details of the recommendations in the BTS code of practice.{6}

Although the evidence is limited to hospitals, the recommendations are applicable to primary as well as secondary care, and to ancillary as well as clinical staff.

13.1.5 RECOMMENDATIONS

R130 Employees new to the NHS who will be working with patients or clinical specimens should not start work until they have completed a TB screen or health check, or documentary evidence is provided of such screening having taken place within the preceding 12 months. D(GPP)

R131 Employees new to the NHS who will not have contact with patients or clinical specimens should not start work if they have signs or symptoms of TB. D(GPP)

R132 Health checks for employees new to the NHS who will have contact with patients or clinical materials should include: D(GPP)

- assessment of personal or family history of TB

- symptom and signs enquiry, possibly by questionnaire
- documentary evidence of TB skin testing (or interferon-gamma testing) and/or BCG scar check by an occupational health professional, not relying on the applicant's personal assessment
- Mantoux result within the last five years, if available.

2006

R133 See R14–7 for screening new NHS employees for latent TB.

2006, amended 2011

R134 Employees who will be working with patients or clinical specimens and who are Mantoux negative (less than 6 mm) should have an individual risk assessment for HIV infection before BCG vaccination is given. D(GPP)

R135 Employees new to the NHS should be offered BCG vaccination, whatever their age, if they will have contact with patients and/or clinical specimens, are Mantoux negative (less than 6 mm) and have not been previously vaccinated. D(GPP)

2006

R136 Employees of any age who are new to the NHS and are from countries of high TB incidence, or who have had contact with patients in settings with a high TB prevalence should have an interferon-gamma test. If negative, offer BCG vaccination as with a negative Mantoux result (see R134 and R135). If positive the person should be referred for clinical assessment for diagnosis and possible treatment of latent infection or active disease. D(GPP)

R137 If a new employee from the UK or other low-incidence setting, without prior BCG vaccination, has a positive Mantoux and a positive interferon-gamma test, they should have a medical assessment and a chest X-ray. They should be referred to a TB clinic for consideration of TB treatment if the chest X-ray is abnormal, or for consideration of treatment of latent TB infection if the chest X-ray is normal. D(GPP)

2006, amended 2011

R138 If a prospective or current healthcare worker who is Mantoux negative (less than 6 mm), declines BCG vaccination, the risks should be explained and the oral explanation supplemented by written advice. If the person still declines BCG vaccination, he or she should not work where there is a risk of exposure to TB. The employer will need to consider each case individually, taking account of employment and health and safety obligations. D(GPP)

2006

R139 Clinical students, agency and locum staff and contract ancillary workers who have contact with patients or clinical materials should be screened for TB to the same standard as new employees in healthcare environments, according to the recommendations set out above. Documentary evidence of screening to this standard should be sought from locum agencies and contractors who carry out their own screening. D(GPP)

R140 NHS trusts arranging care for NHS patients in non-NHS settings should ensure that healthcare workers who have contact with patients or clinical materials in these settings have been screened for TB to the same standard as new employees in healthcare environments (see R130–R139). D(GPP)

Cross-referring:
For details of diagnosing latent TB, see section 5.1.
For details of diagnosing active TB, see section 5.2.
For details of BCG vaccination, see section 11.5.
For examples of 'inform and advise' information, see Appendix H.

2006

This algorithm is currently being reviewed and has been temporarily removed.

2006, amended 2011

Figure 13 Algorithm for new NHS employees

13.2 Healthcare environments: occupational health

2006

13.2.1 Clinical introduction

TB is transmitted through the aerosol route. Hitherto, best practice in hospitals{6} has been that patients with suspected pulmonary tuberculosis are initially admitted to single rooms, vented to the outside, until their sputum status is known and risk assessments for infectiousness and MDR TB are made. The risk assessment should also take into account the immune status of other patients on the ward. These measures should greatly reduce the chance of transmission to staff, but surveys of infection control practice show poor adherence.{371}

Readers should be aware of the Health and Safety Executive guidance in this area, 'Biological agents: managing the risks in laboratories and healthcare premises' (available from **www.hse.gov.uk**).

13.2.2 Methodological introduction

Studies on the prevention of TB transmission in staff currently employed in hospital settings were sought. One cohort study and four non-analytic studies were found.

Five non-analytic studies from the USA{233},{372–375} were excluded due to methodological limitations, presented in Appendix IOne non-analytic study from the UK{371} while methodologically sound, was excluded as it addressed the extent to which TB infection control measures recommended by guidelines were applied in practice, but did not seek to evaluate the effectiveness of recommended measures.

One cohort study{376} and four non-analytic studies{235},{370},{377},{378} reported evidence on the following:

- effects of new infection control measures in reducing TB transmission in hospital workers
- the association between ventilation controls and tuberculin skin test conversion in hospital workers
- effectiveness of occupational health screening for identifying cases of active tuberculous disease in hospital workers
- effects of serial tuberculin skin tests in BCG vaccinated hospital workers.

Studies on screening measures to prevent and control the transmission of TB in employed healthcare workers with HIV infection were also targeted. No evidence was found that met the inclusion criteria, and hence there are no evidence statements for this area.

13.2.3 Evidence statements

Effects of new infection control measures in reducing tuberculosis transmission in hospital workers

Evidence statements are presented in Table 60.

Table 60: Summary of evidence: infection control measures

New infection control measures	Population	N (%) decrease in healthcare worker Mantoux test conversion	Association/statistical significance	Ref and NICE grade

		rate in response to new measures		
1) Introduction of new respiratory isolation rooms. 2) Ventilation with at least 25% fresh air in the work area. 3) Laminar airflow from staff to patients. 4) Plastic droplet shields for staff.	Emergency department staff (intervention group) *vs.* other hospital workers not benefiting from interventions	Baseline: 6/50 (12) *vs.* 51/2514 (2)	RR 5.9 (95% CI 2.7 to 13.1); absolute difference 10% (95% CI 1% to 19%).	{376} 2+
		Post-intervention: 0/64 *vs.* 36/3000 (1.2)	RR not calculable; absolute difference 1.2% (95% CI 1% to 2%)	{376} 2+
1) Higher diagnostic suspicion for infectious TB. 2) Stricter criteria for discontinuation of patient isolation. 3) Stricter criteria for patient adherence to isolation procedures and use of respiratory protection when outside isolation rooms. 4) Restriction of sputum induction and aerosolised pentamidine treatment to isolation rooms. 5) Expansion of anti-TB therapy to include at least two more drugs. 6) Improvements to negative pressure rooms. 7) Upgraded respiratory protection for employees. 8) Improvement in speed of return for diagnostic tests.	Susceptible healthcare workers on an HIV ward	Initial period 7/25 (28) to early follow-up 3/17 (18) to late follow-up period 0/23	p<0.01	{235} 3+

2006

The association between ventilation controls and tuberculin skin test conversion in hospital workers

Evidence statements are presented in Table 61.

Table 61: Summary of evidence: ventilation

Association	Mantoux test conversion rates in healthcare workers	Association/statistical significance	Ref and NICE grade
Ventilation in non-isolation rooms and risk of latent TB infection	Shorter time to conversion significantly associated with being in a non-isolation room with less than two air exchanges *vs.* a room with two plus air exchanges per hour.	Hazard ratio: 3.4 (95% CI 2.1 to 5.8)	{377} 3+
Ventilation in respiratory isolation rooms and risk of latent TB infection	No significant difference in time to conversion for isolation rooms with less than six air exchanges *vs.* those with six plus air exchanges per hour.	Hazard ratio: 1.02 (95% CI 0.8 to 1.3)	{377} 3+
Inadequate ventilation and risk of latent TB infection in nurses and housekeeping staff	Rates significantly associated with inadequately ventilated non-isolation and isolation rooms.	p<0.001	{377} 3+
Inadequate ventilation and risk of latent TB infection in respiratory therapists	Rates significantly associated with inadequate ventilated non-isolation and bronchoscopy rooms.	p<0.001	{377} 3+

Effectiveness of occupational health screening for identifying cases of active tuberculous disease in hospital workers

One study{370} found that occupational health screening in West Midlands NHS hospitals detected fewer cases of active TB in employees than self-referral or contact tracing exercises.

Over a three-year period occupational health surveillance detected one (3.8%) case of active TB *vs.* 23 (88%) TB cases who self-referred with symptoms, and two cases (7.6%) detected via contact tracing exercises. Statistical significance testing was not done. (**3+**)

Effects of serial tuberculin skin tests in BCG vaccinated hospital workers

One prospective study{378} found that an initial Mantoux test, followed by a repeat Mantoux test administered one week later to BCG vaccinated hospital employees

resulted in an increased diameter of induration for the repeat test relative to the first test when read at 48 hours. This was followed by a decreased induration for the repeat test relative to the first at 72 hours.

Mean induration diameter was 7.1 mm for test 1 *vs.* 14.9 mm for repeat test at 48 hours (mean change 7.8 mm; 95%CI 4.2 to 11.4 mm, p<0.001). There was no difference between the tests at 72 hours (mean induration diameter 9.5 mm at test 1 versus 9.7 mm on repeat test, mean change 0.2 mm; 95%CI −4.0 mm to 4.4 mm, p=0.93). (**3+**)

13.2.4 From evidence to recommendations

The evidence base is not easily applicable to a UK NHS setting. Studies to assess the impact of certain isolation and infection control procedures have been performed in North America, using tuberculin skin test conversion (not performed in this context in the UK) as a marker of infection. The population of staff on which these studies are performed is also generally not BCG vaccinated.

There is a duty on staff to report symptoms as part of protecting patients.{62},{379}

Annual reminders are appropriate as a regular intervention in selected staff members, and this is best done at the same time as other annual reminders, for example influenza vaccination. In staff in general, it was felt that the recommendations should promote awareness through 'inform and advise' information.

13.2.5 RECOMMENDATIONS

These recommendations set the standard for NHS organisations and therefore should apply in any setting in England and Wales where NHS patients are treated.

R141 Reminders of the symptoms of TB, and the need for prompt reporting of such symptoms, should be included with annual reminders about occupational health for staff who: D(GPP)

- are in regular contact with TB patients or clinical materials, *or*
- have worked in a high-risk clinical setting for four weeks or longer.

One-off reminders should be given after a TB incident on a ward.

R142 If no documentary evidence of prior screening is available, staff in contact with patients or clinical material who are transferring jobs within the NHS should be screened as for new employees (see section 13.1). D(GPP)

R143 The risk of TB for a new healthcare worker who knows he or she is HIV positive at the time of recruitment should be assessed as part of the occupational health checks. D(GPP)

R144 The employer, through the occupational health department, should be aware of the settings with increased risk of exposure to TB, and that these pose increased risks to HIV-positive healthcare workers. D(GPP)

R145 Healthcare workers who are found to be HIV positive during employment should have medical and occupational assessments of TB risk, and may need to modify their work to reduce exposure. D(GPP)

Cross-referring:
For details of diagnosing latent TB, see section 5.1.
For details of diagnosing active TB, see section 5.2.
For details of BCG vaccination, see section 11.5.
For examples of 'inform and advise' information, see Appendix H.

13.3 Prisons and remand centres

13.3.1 Clinical introduction

In some countries the prison system acts as an amplification system for tuberculosis, with infected inmates causing transmission both within the prison and also in the community after discharge – either while still infectious or without adequate treatment and follow-up arrangements (or both). TB in the prison system of England and Wales was not thought to be a significant problem in the 1980s.{380} Prisoners however are likely to disproportionately include those with social and deprivation risk factors for TB (for example, social exclusion or drug abuse).

More recently, TB in prisons has increased and one community prison in London has been shown to be involved with the transmission of TB in an ongoing isoniazid-resistant TB outbreak.{329}

The 2005 Chief Medical Officer's TB Action Plan{2} sets improvements in prison care as one of the essential activities to be undertaken in improving TB care: 'achieve good coverage of prisons, with arrangements in particular for rapid assessment of suspected cases, supervision of prisoners' TB treatment, and maintenance of uninterrupted care by liaising with the services in their new area of residence prior to their release'. It also calls for strengthened surveillance of TB in prisons.

Throughout this section, the guideline uses the following terminology: in the USA, *jails* mostly house pre-trial detainees or inmates with short-duration sentences, whereas *prisons* house sentenced inmates for longer durations. In the UK, pre-trial detainees are housed in *remand centres* until completion of the trial and sentencing, while sentenced inmates are located in *prisons*. Remand and sentenced prisoners are often mixed within local prisons. In all these circumstances, those detained are referred to as *prisoners*.

13.3.2 Current practice

The review of current services shows that TB service providers either care for prisoners in clinics, or go on prison visits. Prior to the integration of prison medical services into the NHS, prisons would typically have arrangements for secondary care with one local hospital trust. Excluding those that stated that there was no prison or remand centre in their area, about a third cared for prisoners in clinics and a slightly higher proportion undertook prison visits, although some of these were not routine.

13.3.3 Methodological introduction

Studies investigating whether there were effective strategies for the prevention and control of the transmission of TB infection and disease in prisons were targeted. Two randomised controlled trials{206},{208} and four non-analytic studies{381–384} were found. However, two of these{383},{384} were excluded due to methodological

limitations presented in Appendix I. The studies were all conducted in the USA in either prison or jail settings.

13.3.4 Evidence statements

Comparing strategies used in prisons to facilitate completion of prophylaxis in prisoners released back into the community

Two RCTs{206},{208} compared:

- one TB education session *vs.* one TB education session plus a financial incentive
- one TB education session *vs.* one TB education session plus a financial incentive *vs.* TB education sessions administered every two weeks for the duration of an inmate's stay.

The evidence is presented in Table 62.

Table 62: Summary of evidence: educational interventions in prisons

Outcomes	One TB education session control	TB education session plus financial incentive	TB education sessions administered every 2 weeks	Association/statistical significance	Ref and NICE grade
N (%) attendance at follow-up community clinic appointment	7/30 (23.3)	8/31 (25.8)	N/A	NS OR 1.43 (95% CI 0.35 to 3.71, p=0.82)	{206} 1+
	25/104 (24)	42/114 (37)	40/107 (37)	Adjusted OR (pooled results for education and incentive groups): 1.85 (95% CI 1.04 to 3.28, p=0.04)	{208} 1+
N (%) completed prophylaxis	2/31	2/30	N/A	Not reported	{206} 1+
	12/25 (48)	14/42 (33)	24/37 (65)	p=0.02	{208}1 +
			Over twice as likely to complete than control group	Adjusted OR 2.2 (95% CI 1.04 to 4.72, p=0.04)	{208} 1+
		Completion no different from control		Adjusted OR 1.07 (95% CI 0.47 to 2.4)	{208} 1+

		group			

Strategies used to facilitate prevention and control of TB infection and disease within prisons

One non-analytic study{381} investigated the use of screening strategies to detect TB disease in incarcerated inmates.

The evidence is summarised in Table 63.

Table 63: Summary of evidence: detection of active TB in prisons

Population	Prior history/TB symptom reports	Routine TB screening (Mantoux test and chest X-ray)	Cases detected by contact tracing	Statistical significance	NICE grade
N (%) new inmates	13/53 (24)	39/53 (74)	N/A	Not reported	3+
N (%) longer-term inmates (≥ six months)	31/43 (72)	8/43 (19)	4/43 (9)	Not reported	3+

Over the five-year study period, entry screening of 87,518 new prisoners identified 53/55 (96% sensitivity) TB disease cases in this group. (**3+**)

Another non-analytic study{382} reported on the following screening procedures to detect TB disease in new prisoners:

- routine tuberculin skin tests
- routine chest X-ray tests
- use of isolation for prisoners with suspected TB disease.

The evidence is presented in Table 64.

Table 64: Summary of evidence: process of detecting active TB in prisons

	Mantoux test screening period	Chest X-ray screening period	Statistical significance	NICE grade
Detection of cases treated for TB disease, N	8 (denominator not reported)	8/1,830	Not reported	3+
Average time to isolation of suspected TB cases, hours	Exceeded 96 hours	24 hours or less[32]	Not reported	3+

[32] Change in protocol from use of Mantoux test to use of chest X-ray screening eliminated the waiting period for reading Mantoux test results.

Prisoners placed in isolation, N (%)	8/72 (11)	64/72 (89%)[33]	Not reported	3+

13.3.5 From evidence to recommendations

Other than limited data on measures to enhance treatment for latent TB infection in prisoners in the USA, there was little good-quality data in this area. There was a small amount of data to suggest that questionnaires are better than X-rays on initial screening, but that chest X-rays were better for screening symptomatic patients during imprisonment.

It is important to raise awareness of signs and symptoms in prisoners, prison staff and healthcare workers working in prisons and remand centres.

A lack of continuity of care over transfer between prisons and release to the community was seen as a major barrier to treatment completion, and prison medical services should take responsibility for having arrangements in place before either transfer or release.

There is a risk of drug resistance and the possibility of non-adherence, and accordingly DOT is recommended for all prisoners and detainees.

In addition, there is a risk to prison staff, and a level of occupational health equivalent to that of healthcare workers is recommended.

The current practice of taking three sputum samples within 24 hours for microscopy, including a morning sputum sample is supported in the recommendations.

The GDG considered the possibility of screening and BCG vaccination in young offenders' institutions, but agreed that the low number of cases that would be detected could not justify this.

13.3.6 RECOMMENDATIONS

R146 Healthcare workers providing care for prisoners and remand centre detainees should be aware of the signs and symptoms of active TB (see section 5.2). TB services should ensure that awareness of these signs and symptoms is also promoted among prisoners and prison staff. D(GPP)

2006

[33] Only 7/16 inmates ultimately met the case definition for active TB disease for both periods.

R147 Prisoners should be screened for TB by:

- a health questionnaire on each entry to the prison system, *then*D(GPP)
- for those with signs and symptoms of active TB, a chest X-ray, C and three sputum samples taken in 24 hours for TB microscopy, including a morning sputum sample (see section 5.2). D(GPP)

R148 All prisoners receiving treatment for active or latent TB should receive DOT. D(GPP)

R149 Prison medical services should have liaison and handover arrangements to ensure continuity of care before any prisoner on TB treatment is transferred between prisons. D(GPP)

R150 If a prisoner is being treated for active or latent TB, the prison medical services should draw up as early as possible a contingency plan for early discharge, which could happen directly from a court appearance. This plan should include firm arrangements for clinical follow-up and treatment monitoring in the intended district of residence, and should take into account that there may not be a fixed residence arranged for the prisoner after release. The prisoner should be given contact details for a named key worker, who will visit and monitor the prisoner after release and liaise between services involved. D(GPP)

R151 Prison service staff and others who have regular contact with prisoners (for example, probation officers and education and social workers) should have pre- and on-employment screening at the same level as for healthcare workers with patient contact (see sections 13.1 and 13.2). D(GPP)

14 Notification and enhanced surveillance

This chapter sets out the facts of national systems of data collection for TB, as co-ordinated and reported by the HPA's Centre for Infections. Recommendations are not made in this section; readers are reminded that notification is a statutory requirement.

14.1 Tuberculosis surveillance

TB surveillance aims to provide information that can be acted on to prevent and control tuberculosis. High-quality surveillance, as defined in the national TB Action Plan aims to provide the information required at local, national and international levels to:

- identify outbreaks (and other related incidents) and guide immediate action
- monitor trends and measure the occurrence of disease and anti-TB drug resistance
- inform policy
- inform development of services, and
- monitor the success of the TB programme.

Surveillance should also aim to identify population characteristics that predispose to a higher risk of infection and disease in order to appropriately target public health action and health services.

Monitoring the prevalence of infections should be part of surveillance of TB. However, in countries with low disease incidence, high immigration and generalised use of BCG, prevalence surveys on TB infection are very difficult to perform and interpret. Therefore tuberculosis surveillance is mainly based on morbidity associated with disease. It does however also include mortality information (derived from cause of death certification) as annual notifications of infectious diseases (NOIDs) deaths in residents of England and Wales (Office for National Statistics).

Information for TB case reports is currently mainly based on statutory notifications (NOIDs) implemented in 1913 and Enhanced Tuberculosis Surveillance (ETS) implemented in 1999. Treatment outcome monitoring was implemented as part of ETS in 2002. Information on tuberculosis isolates is based on MycobNet (Mycobacterial Surveillance Network) developed in 1994, which collates information on all isolates of *M. tuberculosis* complex confirmed at reference centres for mycobacteriology, including species and drug susceptibility results. On a yearly basis, data on TB cases reports from ETS are linked at national level with information from MycobNet on initial isolates in order to improve the completeness

of laboratory information (including drug susceptibility results) among TB incident cases.

The case definition used to identify incident cases to be included in the reporting system (NOIDs and ETS) is shown overleaf.

Tuberculosis surveillance is constantly evolving to reflect information needs at local and national levels, and availability of new microbiological and information technology. Some new systems are currently under development, including a national microbiological strain typing database and a national TB incidents and outbreaks database (TBIOS), both of which are held at the HPA's Centre for Infections.

All new tuberculosis cases (culture-confirmed cases and other than culture confirmed cases) should be reported.
A **culture-confirmed case** is defined as culture confirmed disease due to *M. tuberculosis* complex (*M. tuberculosis*, *M. bovis* or *M. africanum*).
A **case other than culture confirmed** is defined as a case, that in absence of culture confirmation, meets the following criteria:

1. clinician's judgement that the patient's clinical and/or radiological signs and/or symptoms are compatible with tuberculosis,
2. *and*
3. clinician's decision to treat the patient with a full course of anti-tuberculosis treatment.

Persons receiving preventive chemoprophylaxis are not to be reported to NOIDs or ETS (but may be reported by letter if this information is required locally for service audit or other purposes).

14.2 Statutory notifications of infectious diseases

It is a statutory requirement in England, Wales and Northern Ireland for the diagnosing clinician to notify all cases of clinically diagnosed tuberculosis, whether or not microbiologically confirmed. This statutory requirement for the notification of certain infectious diseases came into being in 1891 and included TB from 1913. Notification must be made to the local 'proper officer', usually the CCDC. Regular returns are made by the proper officer to the Centre for Infections where NOIDs data are collated.

The prime purpose of the NOIDs system is speed in detecting possible outbreaks and epidemics, rather than accuracy of diagnosis. Since 1968 clinical suspicion of a notifiable infection is all that is required, but if a clinical diagnosis of TB later proves incorrect it should be denotified to the local proper officer. The data from this system is the most timely information about TB cases available but is not the most comprehensive or reliable. The dataset is very limited and errors are introduced through problems with removing duplicate entries and excluding, through denotification, cases wrongly diagnosed as TB.

14.3 Enhanced Tuberculosis Surveillance in England, Wales and Northern Ireland

ETS commenced on 1 January 1999 in England and Wales, and the following year in Northern Ireland. Its aims are to continuously provide detailed and comparable information on the epidemiology of tuberculosis, and to enable more precise estimates to be made of trends in tuberculosis incidence in subgroups of the population. ETS is less timely than NOIDs but in this system checking and de-duplication of cases is possible, providing a more accurate number of cases reported as well as more detailed information on each case. The minimum dataset on each case currently includes notification details and demographic, clinical and microbiological information. Cases are reported by clinicians to local coordinators in HPU, then via HPA regional units to the HPA Centre for Infections, Colindale. In most of the regions/countries ETS data are collected through a paper form, entered at local level or at regional level, to then be imported into a national database. The exact process varies according to the HPU or region. For example, in London these data are collected through a internet-based register. ETS provides an annual corrected analysis of reports by age, sex, ethnic group, country of birth, site of disease and region.

14.4 Treatment outcome monitoring in England, Wales and Northern Ireland

Outcome surveillance is an essential tool to determine the effectiveness of the national effort to control TB by providing a valuable insight into the proportion of patients who either complete treatment, die, experience complications resulting in

changed or prolonged drug therapy, or who are lost to follow-up prior to finishing treatment.

Tuberculosis treatment outcome surveillance is the last component of the ETS system and began, following pilot work, in January 2002 on TB cases reported in 2001. Information on outcome of treatment is collected on all TB cases reported at twelve months after starting treatment, or after notification where the treatment starting date is not available.

14.5 MycobNet (UK)

The UK's Mycobacterial Surveillance Network (MycobNet) was developed in 1994 in response to the need for effective information on the antibiotic susceptibility profile of TB cases. A specimen taken from the patient is tested at the local hospital laboratory and if found, or suspected, to be mycobacteria is forwarded to one of seven regional reference centres for mycobacteriology for further investigation.

Information gathered on isolates identified as *M. tuberculosis* complex (*M. tuberculosis*, *M. bovis* or *M. africanum*) is collated through MycobNet at the HPA Centre for Infections, and includes species, drug sensitivity results, and some demographic and clinical data. This information is used to monitor trends in drug resistance in TB, and is also the basis of surveillance of *M. bovis* disease in humans.

15 Priorities for future research

Research recommendation 1

A diagnostic and qualitative study, assessing whether interferon-gamma tests are acceptable to patients and more effective than tuberculin skin tests for:

- predicting subsequent development of active TB, *or*
- diagnosing or ruling out current active TB

- new entrants from high TB prevalence countries
- healthcare workers
- children in high-risk areas who missed neonatal BCG
- contacts of sputum smear-positive TB

• HIV-positive patients.	
Population	• New immigrants from high TB prevalence countries. • Healthcare workers. • Children in high-risk areas who missed neonatal BCG. • Contacts of sputum-positive TB. • HIV-positive patients.
Intervention	Interferon-gamma tests.
Comparison	Tuberculin skin tests.
Outcome	Subsequent development of active TB. Qualitative patient acceptability outcome.

Research recommendation 2

A cluster RCT of DOT compared with self-administered treatment for latent and/or active TB should be conducted in a UK population. This should be targeted at homeless people, and those with a history of non-adherence, alcoholism, drug abuse or mental illness.	
Population	Homeless people, those with a history of non-adherence, alcoholism, drug abuse, or mental illness.
Intervention	DOT.
Comparison	Self-administered treatment.
Outcome	Treatment completion, cure and relapse rates.

Research recommendation 3

A study is needed of people found by new entrant screening (as set out above in 12.7) to be Mantoux positive and interferon-gamma positive, to establish better estimates of the cost-effectiveness of screening and treatment for latent TB infection in this population. This could identify factors predisposing people to developing active TB so that more effective targeted treatment programmes can be developed for latent TB infection..	
Population	New entrants with latent TB infection.
Intervention	Screening and treatment for latent TB infection.
Comparison	Not applicable.
Outcome	Risk factors for the development of active TB and the cost-effectiveness of screening and treatment for latent TB infection (£/QALY).

Research recommendation 4

A case control study, comparing people who developed active or latent TB with those who did not, and comparing the proportions of people in each group who had been vaccinated and the time since vaccination. The aim will be to derive improved estimates of protective efficacy and duration of protection of the BCG vaccine.	
Population	Patients eligible to receive BCG vaccine (this could be neonates, contacts, healthcare workers, new immigrants, schoolchildren).
Intervention	BCG.
Comparison	No BCG.
Outcome	Development of active TB. Possibly the development of latent TB infection as assessed by interferon gamma test (to avoid BCG effects

	on Mantoux test).

Research recommendation 5

A study to ascertain quality-of-life score estimates from those with TB (both active disease and latent infection) including adverse treatment effects, using an appropriate, quality-of-life instrument. This will improve economic decision-making throughout TBcare.	
Population	Those with TB disease or latent infection.
Intervention	Quality of life instrument.
Comparison	None.
Outcome	Quality of life score (single score estimate of health status).

Research recommendation 6

Research is needed to determine whether contact tracing is more effective (in terms of identifying cases of latent infection and active disease) among household contacts than among street homeless contacts of patients with confirmed TB disease (including those using direct-access hostels for the homeless).	
Population	• pulmonary smear-positive TB • pulmonary smear-negative TB • non-pulmonary TB.
Intervention	Contact screening of household contacts.
Comparison	Contact screening of homeless contacts.
Outcome	Case yields for latent TB infection and active TB disease among screened contacts.

Research recommendation 7

Research is needed to determine whether Port of Arrival scheme referrals with incentives for attending screening identify more cases of latent TB infection and active TB disease in new entrants than Port of Arrival scheme referrals with no incentives.	
Population	New immigrants from high TB prevalence (40+/100,000) countries.
Intervention	Port of arrival referrals with screening attendance incentives.
Comparison	Port of arrival referrals with no screening attendance incentives.
Outcome	Case yields for TB infection and active TB disease in intervention and comparison groups.

Research recommendation 8

Research is needed to determine whether incentives for attending chest X-ray screening achieve better coverage in the homeless population, or identify more cases of latent TB infection and active TB disease, than no incentives.	
Population	Individuals in temporary accommodation, hostels, and street homeless.
Intervention	Invitation with incentives to attend chest X-ray screening.
Comparison	Invitation without incentives to attend chest X-ray screening.
Outcome	Case yields for TB infection and active TB disease in intervention and comparison groups.

Other potential research recommendations

These are other topics where evidence is lacking, and where new research could improve future guidelines. They are not developed to the extent of the eight priorities above.

- A multicentre RCT in patients with bacteriologically confirmed tuberculous meningitis, comparing six to 11 months of chemotherapy with 12 months of treatment to ascertain if different treatment duration affects mortality and residual disability.

- Effectiveness of skills training for TB key workers, eg in motivational interviewing methods.

- An RCT of prisoners being treated for TB disease or latent infection who are discharged early, to assess whether contingency plans are cost-effective and improve treatment completion, cure and relapse rates.

- Is contact tracing using one method (eg home screening and follow-up of contacts) more effective than another (eg clinic-based screening and follow-up of contacts) in identifying cases of latent infection and active TB disease among adult and child household contacts of patients with confirmed TB disease?

- What is the impact of screening casual (low exposure) *vs.* close (high exposure) contacts of patients with confirmed TB on the yield of latent tuberculosis infection and active TB disease cases?

- Does screening of patient contacts in the same hospital bay as a pulmonary smear-positive index case of TB yield more cases of latent TB infection and active disease compared to other patient contacts on the same hospital ward?

A number of studies were suggested in areas not addressed by guideline questions, therefore the current evidence base for these areas is not known. These were:

- a study investigating risk factors for adverse outcomes from tuberculosis (deaths, acquired resistance and loss to follow-up)

- studies on patient and healthcare delay, to identify how to shorten the period of infectivity of active cases
- a diagnostic study of the efficacy of interferon-gamma testing in confirming active non-respiratory tuberculosis if other tests have remained inconclusive
- a study on whether interferon-gamma tests are more effective than chest X-ray screening for identifying cases of active TB disease in new immigrants undergoing TB screening.

16 References 2006

1. National Institute for Health and Clinical Excellence. *Guideline development methods: information for national collaborating centres and guideline developers.* London: NICE, 2005. Available from www.nice.org
2. Department of Health. *Stopping tuberculosis in England: an action plan from the Chief Medical Officer.* London: DH, 2004
3. Department of Health, The Scottish Office, The Welsh Office. *Immunisation against infectious diseases 1996 – the Green Book.* London: HMSO, 1996.
4. National Collaborating Centre for Chronic Conditions. *Tuberculosis: guideline development methodology pack.* London: NCC-CC, 2004.
5. British Medical Association, Royal Pharmaceutical Society of GB.*British National Formulary; no. 48.* London: Pharmaceutical Press, 2004
6. Joint Tuberculosis Committee of the British Thoracic Society. Control and prevention of tuberculosis in the United Kingdom: code of practice 2000. *Thorax* 2000;55(11):887–901.
7. Ormerod LP, Joint Tuberculosis Committee of the British Thoracic Society. Serial surveys of the tuberculosis nursing and support provision in the high incidence districts of England and Wales. *Communicable Disease & Public Health* 2002;5(4):336–337.
8. Pozniak AL, Miller RF, Lipman MC. *BHIVA treatment guidelines for TB/HIV infection.* London: British HIV Association, 2005.
9. Brock I, Weldingh K, Lillebaek T, Follman F, Anderson P. Comparison of a new specific blood test and the skin test in tuberculosis contacts. *American Journal of Respiratory & Critical Care Medicine* 2004; 170(1):65–69.
10. Chapman AL, Munkanta M, Wilkinson KA, Pathan AA *et al.* Rapid detection of active and latent tuberculosis infection in HIV-positive individuals by enumeration of *Mycobacterium tuberculosis*-specific T cells. *AIDS* 2002;16(17):2285–2293.
11. Ewer K, Deeks J, Alvarez L, Bryant G *et al.* Comparison of T-cell-based assay with tuberculin skin test for diagnosis of *Mycobacterium tuberculosis* infection in a school tuberculosis outbreak. *Lancet* 2003; 361(9364):1168–1173.
12. Ferrara G, Losi M, Meacci M, Meccugni B *et al.* Routine hospital use of a commercial whole blood interferon-gamma assay for tuberculosis infection. *American Journal of Respiratory & Critical Care Medicine* 2005;172:631–635.
13. Hill PC, Brookes RH, Fox A, Fielding K *et al.* Large-scale evaluation of enzyme-linked immunospot assay and skin test for diagnosis of *Mycobacterium tuberculosis* infection against a gradient of exposure in the Gambia. *Clinical Infectious Diseases* 2004;38(7):966–973.
14. Johnson PD, Stuart RL, Grayson ML, Olden D *et al.* Tuberculin-purified protein derivative-, MPT-64-, and ESAT-6-stimulated gamma interferon responses in medical students before and after *Mycobacterium bovis* BCG vaccination and in patients with tuberculosis. *Clinical & Diagnostic Laboratory Immunology* 1999;6(6):934–937.
15. Kang YA, Lee HW, Yoon HI, Cho B *et al.* Discrepancy between the tuberculin skin test and the whole-blood interferon gamma assay for the diagnosis of latent tuberculosis infection in an intermediate tuberculosis-burden country. *Journal of the American Medical Association* 2005;293(22):2756–2761.
16. Lalvani A, Pathan AA, McShane H, Wilkinson RJ *et al.* Rapid detection of *Mycobacterium tuberculosis* infection by enumeration of antigen-specific T cells. *American Journal of Respiratory & Critical Care Medicine* 2001;163(4):824–828.
17. Lalvani A. Enhanced contact tracing and spatial tracking of *Mycobacterium tuberculosis* infection by enumeration of antigen-specific T cells. *Lancet* 2001;357(9273):2017–2021.
18. Pai M, Gokhale K, Joshi R, Dogra S *et al. Mycobacterium tuberculosis* infection in health care workers in rural India: comparison of a whole-blood interferon gamma assay with tuberculin skin testing. *Journal of the American Medical Association* 2005;293(22):2746–2755.

19. Richeldi L, Ewer K, Losi M, Bergamini BM *et al.* T cell-based tracking of multidrug resistant tuberculosis infection after brief exposure. *American Journal of Respiratory & Critical Care Medicine* 2004;170(3): 288–295.
20. Pai M, Riley LW, Colford JM, Jr. Interferon-gamma assays in the immunodiagnosis of tuberculosis: *a* systematic review. *Lancet Infectious Diseases* 2004;4(12):761–776.
21. Department of Health. *Immunisation against infectious disease – the 'Green Book'.* London: DOH, 2006.
22. Davies PD. *Clinical Tuberculosis. Third ed.* London: Arnold, 2003.
23. El Sony A, Enarson D, Khamis A, Baraka O, Bjune G. Relation of grading of sputum smears with clinical features of tuberculosis patients in routine practice in Sudan. *International Journal of Tuberculosis & Lung Disease* 2002;6(2):91–97.
24. Brandli O. The clinical presentation of tuberculosis. *Respiration* 1998;65(2):97–105.
25. Wisnivesky JP, Kaplan J, Henschke C, McGinn TG, Crystal RG. Evaluation of clinical parameters to predict *Mycobacterium tuberculosis* in inpatients. *Archives of Internal Medicine* 2000;160(16):2471–2476.
26. Rose AM, Watson JM, Graham C, Nunn AJ *et al.* Tuberculosis at the end of the 20th century in England and Wales: results of a national survey in 1998. *Thorax* 2001;56(3):173–179.
27. Kumar D, Watson JM, Charlett A, Nicholas S, Darbyshire JH. Tuberculosis in England and Wales in 1993: results of a national survey. *Thorax* 1997;52:1060–1067.
28. Davies PD, Humphries MJ, Byfield SP, Nunn AJ *et al.* Bone and joint tuberculosis: a survey of notifications in England and Wales. *Journal of Bone & Joint Surgery (BR)* 1984;66(3):326–330.
29. Hodgson SP, Ormerod LP. Ten-year experience of bone and joint tuberculosis in Blackburn 1978-1987. *Journal of the Royal College of Surgeons of Edinburgh* 1990;35(4):259–262.
30. Mukherjee P, Singhal AK. Intestinal tuberculosis: 500 operated cases. *Proceedings of the Association of Surgeons of East Africa* 1979;2:70–75.
31. Khan MR, Khan IR, Pal KM. Diagnostic issues in abdominal tuberculosis. *Journal of the Pakistan Medical Association* 2001;51(4):138–142.
32. Klimach OE, Ormerod LP. Gastrointestinal tuberculosis: *a* retrospective review of 109 cases in a district general hospital. *Quarterly Journal of Medicine* 1985;56(221):569–578.
33. Sherman S, Rohwedder JJ, Ravikrishnan KP, Weg JG. Tuberculous enteritis and peritonitis: report of 36 general hospital cases. *Archives of Internal Medicine* 1980;140(4):506–508.
34. Bastani B, Shariatzadeh MR, Dehdashti F. Tuberculous peritonitis: report of 30 cases and review of the literature. *Quarterly Journal of Medicine* 1985;56(221):549–557.
35. Anand AC, Patnaik PK, Bhalla VP, Chaudhary R *et al.* Massive lower intestinal bleeding: a decade of experience. *Tropical Gastroenterology* 2001;22(3):131–134.
36. The Medical Research Council Tuberculosis and Chest Diseases Unit. National survey of tuberculosis notifications in England and Wales in 1983: characteristics of disease. *Tubercle* 1987;68(1):19–32.
37. Sutherland AM. Gynaecological tuberculosis: analysis of a personal series of 710 cases. *Australian and New Zealand Journal of Obstetrics and Gynaecology* 1985;25(3):203–207.
38. Yates VM, Ormerod LP. Cutaneous tuberculosis in Blackburn district (U.K.): a 15-year prospective series, 1981–95. *British Journal of Dermatology* 1997;136(4):483–489.
39. Hesseling AC, Schaaf HS, Gie RP, Starke JR, Beyers N. A critical review of diagnostic approaches used in the diagnosis of childhood tuberculosis. *International Journal of Tuberculosis & Lung Disease* 2002;6(12): 1038–1045.
40. Joint Tuberculosis Committee of the British Thoracic Society. Management of opportunistic mycobacterial infections: joint tuberculosis committee guidelines 1999. *Thorax* 2000;55:210–218.
41. Klein NC, Duncanson FP, Lenox TH, III, Pitta A *et al.* Use of mycobacterial smears in the diagnosis of pulmonary tuberculosis in AIDS/ARC patients. *Chest* 1989;95(6):1190–1192.
42. Merrick ST, Sepkowitz KA, Walsh J, Damson L *et al.* Comparison of induced versus expectorated sputum for diagnosis of pulmonary tuberculosis by acid-fast smear. *American Journal of Infection Control* 1997; 25(6):463–466.

43. Yajko DM, Nassos PS, Sanders CA, Madej JJ, Hadley WK. High predictive value of the acid-fast smear for *Mycobacterium tuberculosis* despite the high prevalence of *Mycobacterium avium* complex in respiratory specimens. *Clinical Infectious Diseases* 1994;19(2):334–336.

44. Finch D, Beaty CD. The utility of a single sputum specimen in the diagnosis of tuberculosis: comparison between HIV-infected and non-HIV-infected patients. *Chest* 1997;111(5):1174–1179.

45. Peterson EM, Nakasone A, Platon-DeLeon JM, Jang Y *et al.* Comparison of direct and concentrated acid-fast smears to identify specimens culture positive for *Mycobacterium* spp. *Journal of Clinical Microbiology* 1999;37(11):3564–3568.

46. Warren JR, Bhattacharya M, De Almeida KN, Trakas K, Peterson LR. A minimum 5.0 ml of sputum improves the sensitivity of acid-fast smear for *Mycobacterium tuberculosis*. *American Journal of Respiratory & Critical Care Medicine* 2000;161(5):1559–1562.

47. Smith RL, Yew K, Berkowitz KA, Aranda CP. Factors affecting the yield of acid-fast sputum smears in patients with HIV and tuberculosis. *Chest* 1994;106(3):684–686.

48. Ulukanligil M, Aslan G, Tasci S. A comparative study on the different staining methods and number of specimens for the detection of acid fast bacilli. *Memorias do Instituto Oswaldo Cruz* 2000;95(6):855–858.

49. Wilcke JT, Kok-Jensen A. Diagnostic strategy for pulmonary tuberculosis in a low-incidence country: results of chest X-ray and sputum cultured for *Mycobacterium tuberculosis*. *Respiratory Medicine* 1997; 91(5):281–285.

50. De Villiers RV, Andronikou S, Van de WS. Specificity and sensitivity of chest radiographs in the diagnosis of paediatric pulmonary tuberculosis and the value of additional high-kilovolt radiographs. *Australasian Radiology* 2004;48(2):148–153.

51. Greenberg SD, Frager D, Suster B, Walker S *et al.* Active pulmonary tuberculosis in patients with AIDS: spectrum of radiographic findings (including a normal appearance). *Radiology* 1994;193(1):115–119.

52. Asimos AW, Ehrhardt J. Radiographic presentation of pulmonary tuberculosis in severely immunosuppressed HIV-seropositive patients. *American Journal of Emergency Medicine* 1996;14(4):359–363.

53. Somu N, Swaminathan S, Paramasivan CN, Vijayasekaran D *et al.* Value of bronchoalveolar lavage and gastric lavage in the diagnosis of pulmonary tuberculosis in children. *Tubercle & Lung Disease* 1995;76(4): 295–299.

54. Laven GT. Diagnosis of tuberculosis in children using fluorescence microscopic examination of gastric washings. *American Review of Respiratory Disease* 1977;115(5):743–749.

55. Zar HJ, Hanslo D, Apolles P, Swingler G, Hussey G. Induced sputum versus gastric lavage for microbiological confirmation of pulmonary tuberculosis in infants and young children: a prospective study. *Lancet* 2005;365(9454):130–134.

56. Cowie RL, Langton ME, Escreet BC. Diagnosis of sputum smear- and sputum culture-negative pulmonary tuberculosis. *South African Medical Journal* 1985;68(12):878.

57. A controlled trial of 2-month, 3-month, and 12-month regimens of chemotherapy for sputum-smear-negative pulmonary tuberculosis. Results at 60 months. *American Review of Respiratory Disease* 1984; 130(1):23–28.

58. Nataraj G, Kurup S, Pandit A, Mehta P. Correlation of fine needle aspiration cytology, smear and culture in tuberculous lymphadenitis: a prospective study. *Journal of Postgraduate Medicine* 2002;48(2):113–116.

59. Bekedam HJ, Boeree M, Kamenya A, Liomba G *et al.* Tuberculous lymphadenitis: a diagnostic problem in areas of high prevalence of HIV and tuberculosis. *Transactions of the Royal Society of Tropical Medicine & Hygiene* 1997;91(3):294–297.

60. Lapuerta P, Martin SE, Ellison E. Fine-needle aspiration of peripheral lymph nodes in patients with tuberculosis and HIV. *American Journal of Clinical Pathology* 1997;107(3):317–320.

61. Cutler RR, Baithun SI, Doran HM, Wilson P. Association between the histological diagnosis of tuberculosis and microbiological findings. *Tubercle & Lung Disease* 1994;75(1):75–79.

62. General Medical Council. *Serious communicable diseases.* London: GMC, 1997. (www.gmc-uk.org/guidance/library/serious_communicable_diseases.asp)

63. Public Health (Control of Disease) Act 1984. London: DH, 1984. Available from the The Stationery Office.

64. Drobniewski FA. Diagnosing multidrug resistant tuberculosis in Britain: clinical suspicion should drive rapid diagnosis. *British Medical Journal* 1998;317(7168):1263–1264.

65. Goyal M, Shaw RJ, Banerjee DK, Coker RJ *et al.* Rapid detection of multidrug-resistant tuberculosis. *European Respiratory Journal* 1997;10(5):1120–1124.

66. NHS Health Technology Assessment Programme. *The clinical and cost-effectiveness of diagnostic tests for the detection of mycobacterial infection.* 2004. (**www.ncchta.org/project.asp?PjtId=1247**)

67. Deeks J. 'Systematic reviews of evaluations of diagnostic and screening tests'. In: Egger M, Davey Smith G, Altman D (eds). *Systematic reviews in health care: meta-analysis in context. Second ed. BMJ* 2001;323: 224–228.

68. Joint Tuberculosis Committee of the British Thoracic Society. BTS guidelines: chemotherapy and management of tuberculosis in the United Kingdom: recommendations 1998. *Thorax* 1998;53(7):536–548.

69. British Thoracic Society. A controlled trial of six months' chemotherapy in pulmonary tuberculosis. Final report: results during the 36 months after the end of chemotherapy and beyond. *British Journal of Diseases of the Chest* 1984;78(4):330–336.

70. Ormerod LP, Horsfield N. Short-course antituberculous chemotherapy for pulmonary and pleural disease: five years' experience in clinical practice. *British Journal of Diseases of the Chest* 1987;81(3): 268–271.

71. Ormerod LP, McCarthy OR, Rudd RM, Horsfield N. Short course chemotherapy for pulmonary tuberculosis. *Respiratory Medicine* 1991;85(4):291–294.

72. Ormerod LP, Prescott RJ. Inter-relations between relapses, drug regimens and compliance with treatment in tuberculosis. *Respiratory Medicine* 1991;85(3):239–242.

73. Nemir RL, Cardona J, Vaziri F, Toledo R. Prednisone as an adjunct in the chemotherapy of lymph node-bronchial tuberculosis in childhood: a double-blind study. II. Further term observation. *American Review of Respiratory Disease* 1967;95(3):402–410.

74. Gelband H. Regimens of less than six months for treating tuberculosis. *The Cochrane Library* 1999;(4):CD001362.

75. Mehrotra ML, Gautam KD, Chaube CK. Shortest possible acceptable, effective ambulatory chemotherapy in pulmonary tuberculosis: preliminary report. *American Review of Respiratory Disease* 1981;124(3):239–244.

76. Santha T, Nazareth O, Krishnamurthy MS, Balasubramanian R *et al.* Treatment of pulmonary tuberculosis with short course chemotherapy in south India-5-year follow up. *Tubercle* 1989;70(4):229–234.

77. Balasubramanian R, Sivasubramanian S, Vijayan VK, Ramachandran R *et al.* Five year results of a three-month and two 5-month regimens for the treatment of sputum-positive pulmonary tuberculosis in south India. *Tubercle* 1990;71(4):253–258.

78. Sputum-smear-negative pulmonary tuberculosis: controlled trial of 3-month and 2-month regimens of chemotherapy. *Lancet* 1979;1(8131):1361–1363.

79. Hong Kong Chest Service/Tuberculosis Research Centre, Madras/British Medical Research Council.A controlled trial of 3-month, 4-month, and 6-month regimens of chemotherapy for sputum-smear-negative pulmonary tuberculosis: results at 5 years. *American Review of Respiratory Disease* 1989;139(4): 871–876.

80. Clinical trial of six-month and four-month regimens of chemotherapy in the treatment of pulmonary tuberculosis. *American Review of Respiratory Disease* 1979;119(4):579–585.

81. Eule H, Beck H, Evers H, Fischer P *et al.* Daily ultrashort chemotherapy and intermittent short-term chemotherapy with 4 drugs of communicable pulmonary tuberculosis treated for the first time: results of a cooperative multicenter study. *Zeitschrift fur Erkrankungen der Atmungsorgane* 1986;167(1–2):29–41.

82. Agarwal SK, Roy DC, Pal D. Once a week short-term tuberculosis therapy. *Asian Medical Journal* 1983; 26(6):390–397.

83. Mwandumba HC, Squire SB. Fully intermittent dosing with drugs for tuberculosis. *The Cochrane Library* 2001;(4).

84. Mitchison DA, Aber V, Allen BW. Controlled trial of four thrice-weekly regimens and a daily regimen all given for 6 months for pulmonary tuberculosis. *Lancet* 1981;1(8213):171–174.

85. Castelo A, Jardim JR, Goihman S, Kalckman AS *et al.* Comparison of daily and twice-weekly regimens to treat pulmonary tuberculosis. *Lancet* 1989;2(8673):1173–1176.

86. Jindani A, Nunn AJ, Enarson DA. Two 8-month regimens of chemotherapy for treatment of newly diagnosed pulmonary tuberculosis: international multicentre randomised trial. *Lancet* 2004;364(9441):1244–1251.

87. Zierski M, Bek E, Long MW, Snider DE, Jr. Short-course (6 month) cooperative tuberculosis study in Poland: results 18 months after completion of treatment. *American Review of Respiratory Disease* 1980; 122(6):879–889.

88. Prasad R, Garg R, Mukerji PK, Jain A. Comparative study of daily and thrice weekly intermittent regimens given for six months in the treatment of pulmonary tuberculosis. *Journal of Internal Medicine of India* 2001;4(1):1–3.

89. Alwood K, Keruly J, Moore-Rice K, Stanton DL *et al.* Effectiveness of supervised, intermittent therapy for tuberculosis in HIV-infected patients. *AIDS* 1994;8(8):1103–1108.

90. Naude JMTW, Donald PR, Hussey GD, Kibel MA *et al.* Twice weekly vs. daily chemotherapy for childhood tuberculosis. *Pediatric Infectious Disease Journal* 2000;19(5):405–410.

91. Geiter LJ, O'Brien RJ, Combs DL, Snider DE, Jr. United States Public Health Service Tuberculosis Therapy Trial 21: preliminary results of an evaluation of a combination tablet of isoniazid, rifampin and pyrazinamide. *Tubercle* 1987;68(2 Suppl):41–46.

92. Girling DJ, Chan SL. Controlled trial of 2, 4, and 6 months of pyrazinamide in 6-month, three-times-weekly regimens for smear-positive pulmonary tuberculosis, including an assessment of a combined preparation of isoniazid, rifampin, and pyrazinamide: results at 30 months. *American Review of Respiratory Disease* 1991;143(4 I):700–706.

93. Zhang LX, Kan GQ, Tu DH, Wan LY, Faruqi AR. Fixed-dose combination chemotherapy versus multiple, single-drug chemotherapy for tuberculosis. *Current Therapeutic Research Clinical and Experimental* 1996;57:849–856.

94. Teo SK. Assessment of a combined preparation of isoniazid, rifampicin and pyrazinamide (Rifater) in the initial phase of chemotherapy in three 6-month regimens for smear-positive pulmonary tuberculosis: a five-year follow-up report. *International Journal of Tuberculosis & Lung Disease* 1999;3(2):126–132.

95. Su WJ, Perng RP. Fixed-dose combination chemotherapy (Rifater/Rifinah) for active pulmonary tuberculosis in Taiwan: a two-year follow-up. *International Journal of Tuberculosis & Lung Disease* 2002;6(11):1029–1032.

96. Gravendeel JMT, Asapa AS, Becx-Bleumink M, Vrakking HA. Preliminary results of an operational field study to compare side-effects, complaints and treatment results of a single-drug short-course regimen with a four-drug fixed-dose combination (4FDC) regimen in South Sulawesi, Republic of Indonesia. *Tuberculosis* 2003;83(1–3):183–186.

97. Ormerod LP, Bentley C. The management of lymph node tuberculosis notified in England and Wales in 1993. *Journal of the Royal College of Physicians of London* 1997;31(6):666–668.

98. Ormerod LP, Bentley C. The management of pulmonary tuberculosis notified in England and Wales in 1993. *Journal of the Royal College of Physicians of London* 1997;31(6):662–665.

99. Mitchison DA, Nunn AJ. Influence of initial drug resistance on the response to short-course chemotherapy of pulmonary tuberculosis. *American Review of Respiratory Disease* 1986;133(3):423–430.

100. Acquired rifamycin resistance in persons with advanced HIV disease being treated for active tuberculosis with intermittent rifamycin-based regimens. *Morbidity & Mortality Weekly Report* 2002;51(10):214–215.

101. Jindani A, Aber VR, Edwards EA, Mitchison DA. The early bactericidal activity of drugs in patients with pulmonary tuberculosis. *American Review of Respiratory Disease* 1980;121(6):939–949.

102. Rouillon A, Perdrizet S, Parrot R. Transmission of tubercle bacilli: the effects of chemotherapy. *Tubercle* 1976;57(4):275–299.

103. Tokars JI, McKinley GF, Otten J, Woodley C *et al.* Use and efficacy of tuberculosis infection control practices at hospitals with previous outbreaks of multidrug-resistant tuberculosis. *Infection Control & Hospital Epidemiology* 2001;22(7):449–455.

104. Health and Safety Executive. *Respiratory protective equipment at work: a practical guide.* London: HSE, 2005.

105. NHS Estates. *Isolation facilities in acute settings: in patient accommodation: options for choice.* Health Building Notes 4 supplement 1. London, 2005.

106. Wallgren A. The timetable of tuberculosis. *Tubercle* 1948;29:245–251.

107. Ormerod LP, Horsfield N. Miliary tuberculosis in a high prevalence area of the United Kingdom. Blackburn 1978–93. *Respiratory Medicine* 1995;89(8):555–557.

108. MRC Streptomycin in Tuberculosis Trials Committee. Streptomycin treatment in tuberculous meningitis. *Lancet* 1947;1:582–597.

109. Teoh R, Humphries MJ, O'Mahoney G. Symptomatic intracranial tuberculoma developing during treatment of tuberculosis: a report of 10 cases and a review of the literature. *Quarterly Journal of Medicine* 1987;63(241):449–460.

110. Martineau AR, Lowey H, Tocque K, Davies PD. Decreasing tuberculosis case fatality in England and Wales, 1988–2001. *International Journal of Tuberculosis & Lung Disease* 2004;8(6):737–742.

111. Doganay M, Calangu S, Turgut H, Bakir M, Aygen B. Treatment of tuberculous meningitis in Turkey. *Scandinavian Journal of Infectious Diseases* 1995;27(2):135–138.

112. *Short-course chemotherapy for tuberculous meningitis.* 89 A.D. Oct 22; the XIVth World Congress of Neurology. 1990.

113. Chotmongkol V. Treatment of tuberculous meningitis with 6-month course of chemotherapy. *Southeast Asian Journal of Tropical Medicine & Public Health* 1991;22(3):372–374.

114. Alarcon F, Escalante L, Perez Y, Banda H*et al.* Tuberculous meningitis: short course of chemotherapy. *Archives of Neurology* 1990;47(12):1313–1317.

115. Acharya VN, Kudva BT, Retnam VJ, Mehta PJ. Adult tuberculous meningitis: comparative study of different chemotherapeutic regimens. *Journal of the Association of Physicians of India* 1985;33(9):583–585.

116. Loenhout-Rooyackers JH, Keyser A, Laheij RJ, Verbeek AL, van der Meer JW. Tuberculous meningitis: is a 6-month treatment regimen sufficient? *International Journal of Tuberculosis & Lung Disease* 2001; 5(11):1028–1035.

117. Jacobs RF, Sunakorn P, Chotpitayasunonah T, Pope S, Kelleher K. Intensive short course chemotherapy for tuberculous meningitis. *Pediatric Infectious Disease Journal* 1992;11(3):194–198.

118. Donald PR, Schoeman JF, Van Zyl LE, De Villiers JN *et al.* Intensive short course chemotherapy in the management of tuberculous meningitis. *International Journal of Tuberculosis & Lung Disease* 1998; 2(9):704–711.

119. Phuapradit P, Vejjajiva A. Treatment of tuberculous meningitis: role of short-course chemotherapy. *Quarterly Journal of Medicine* 1987;62(239):249–258.

120. Goel A, Pandya SK, Satoskar AR. Whither short-course chemotherapy for tuberculous meningitis? *Neurosurgery* 1990;27(3):418–421.

121. Humphries MJ, Teoh R, Lau J, Gabriel M. Factors of prognostic significance in Chinese children with tuberculous meningitis. *Tubercle* 1990;71(3):161–168.

122. Ramachandran P, Duraipandian M, Nagarajan M, Prabhakar R *et al.* Three chemotherapy studies of tuberculous meningitis in children. *Tubercle* 1986;67(1):17–29.

123. Ramachandran P, Duraipandian M, Reetha AM, Mahalakshmi SM, Prabhakar R. Long-term status of children treated for tuberculous meningitis in south India. *Tubercle* 1989;70(4):235–239.

124. Prasad K, Volmink J, Menon GR. Steroids for treating tuberculous meningitis. *The Cochrane Library* 2000;(3):CD002244.

125. O'Toole RD, Thornton GF, Mukherjee MK, Nath RL. Dexamethasone in tuberculous meningitis: relationship of cerebrospinal fluid effects to therapeutic efficacy. *Annals of Internal Medicine* 1969; 70(1):39–48.

126. Girgis NI, Farid Z, Kilpatrick ME, Sultan Y, Mikhail IA. Dexamethasone adjunctive treatment for tuberculous meningitis. *Pediatric Infectious Disease Journal* 1991;10(3):179–183.

127. Kumarvelu S, Prasad K, Khosla A, Behari M, Ahuja GK. Randomized controlled trial of dexamethasone in tuberculous meningitis. *Tubercle & Lung Disease* 1994;75(3):203–207.

128. Chotmongkol V, Jitpimolmard S, Thavornpitak Y. Corticosteroid in tuberculous meningitis. *Journal of the Medical Association of Thailand* 1996;79(2):83–90.

129. Schoeman JF, Van Zyl LE, Laubscher JA, Donald PR. Effect of corticosteroids on intracranial pressure, computed tomographic findings, and clinical outcome in young children with tuberculous meningitis. *Pediatrics* 1997;99(2):226–231.

130. Lardizabal DV, Roxas AA. Dexamethasone as adjunctive therapy in adult patients with probable tuberculous meningitis stage II and IH: an open randomized controlled trial. *The Philippine Journal of Neurology* 1998;4:2–11.

131. Dooley DP, Carpenter JL, Rademacher S. Adjunctive corticosteroid therapy for tuberculosis: *a* critical reappraisal of the literature. *Clinical Infectious Diseases* 1997;25(4):872–887.

132. Thwaites GE, Nguyen HD, Hoang TQ, Do TT, Nguyen TC. Dexamethasone for the treatment of tuberculous meningitis in adolescents and adults. *New England Journal of Medicine* 2004;351(17): 1741–1751.

133. Ormerod LP. Tuberculosis in pregnancy and the puerperium. *Thorax* 2001;56(6):494–499.

134. Campbell IA, Dyson AJ. Lymph node tuberculosis: *a* comparison of various methods of treatment. *Tubercle* 1977;58(4):171–179.

135. British Thoracic Society Research Committee. Short course chemotherapy for tuberculosis of lymph nodes: a controlled trial. *British Medical Journal* (Clinical research ed) 1985;290(6475):1106–1108.

136. British Thoracic Society Research Committee. Six-months versus nine-months chemotherapy for tuberculosis of lymph nodes: preliminary results. *Respiratory Medicine* 1992;86(1):15–19.

137. Campbell IA, Ormerod LP, Friend JA, Jenkins PA, Prescott RJ. Six months versus nine months chemotherapy for tuberculosis of lymph nodes: final results. *Respiratory Medicine* 1993;87(8):621–623.

138. Loenhout-Rooyackers JH, Laheij RJ, Richter C, Verbeek AL. Shortening the duration of treatment for cervical tuberculous lymphadenitis. *European Respiratory Journal* 2000;15(1):192–195.

139. Yuen AP, Wong SH, Tam CM, Chan SL *et al.* Prospective randomized study of thrice weekly six-month and nine-month chemotherapy for cervical tuberculous lymphadenopathy. *Otolaryngology – Head & Neck Surgery* 1997;116(2):189–192.

140. Tuberculosis Section: Health Protection Agency Centre for Infections. *Annual report on tuberculosis cases reported in 2002 in England, Wales and Northern Ireland: enhanced tuberculosis surveillance.* London: Health Protection Agency, 2005.

141. Upadhyay SS, Saji MJ, Yau AC. Duration of antituberculosis chemotherapy in conjunction with radical surgery in the management of spinal tuberculosis. *Spine* 1996;21(16):1898–1903.

142. Medical Research Council Working Party on tuberculosis of the spine Five-year assessment of controlled trials of short-course chemotherapy regimens of 6, 9 or 18 months' duration for spinal tuberculosis in patients ambulatory from the start or undergoing radical surgery. *International Orthopaedics* 1999;23(2):73–81.

143. Parthasarathy R, Sriram K, Santha T, Prabhakar R *et al.* Short-course chemotherapy for tuberculosis of the spine: a comparison between ambulant treatment and radical surgery – ten-year report. *Journal of Bone & Joint Surgery British Volume* 1999;81B(3):464–471.

144. Medical Research Council Working Party on Tuberculosis of the Spine. A controlled trial of ambulant outpatient treatment and in-patient rest in bed in the management of tuberculosis of the spine in young Korean patients on standard chemotherapy. *Journal of Bone & Joint Surgery British Volume* 1973;55B(4): 678–697.

145. Medical Research Council Working Party on Tuberculosis of the Spine. A 5-year assessment of controlled trials of inpatient and outpatient treatment and of plaster-of-paris jackets for tuberculosis of the spine in children on standard chemotherapy. *Journal of Bone & Joint Surgery British Volume* 1976;58B(4): 399–411.

146. Medical Research Council Working Party on Tuberculosis of the Spine. A controlled trial of plaster-of-paris jackets in the management of ambulatory outpatient treatment of tuberculosis of the spine in children on standard chemotherapy: a study in Pusan, Korea. *Tubercle* 1973;54(4):261–282.

147. Medical Research Council Working Party. A controlled trial of debridement and ambulatory treatment in the management of tuberculosis of the spine in patients on standard chemotherapy: *a* study in Bulawayo, Rhodesia. *Journal of Tropical Medicine & Hygiene* 1974;77(4):72–92.

148. Medical Research Council Working Party on tuberculosis of the spine. A controlled trial of anterior spinal fusion and debridement in the surgical management of tuberculosis of the spine in patients on standard chemotherapy: *a* study in two centres in South Africa. *Tubercle* 1978;59(2):79–105.

149. Medical Research Council Working Party on Tuberculosis of the Spine. Five-year assessments of controlled trials of ambulatory treatment, debridement and anterior spinal fusion in the management of tuberculosis of the spine: studies in Bulawayo (Rhodesia) and in Hong Kong. *Journal of Bone & Joint Surgery British Volume* 1978;60B(2):163–177.

150. Medical Research Council Working Party on Tuberculosis of the Spine. A controlled trial of anterior spinal fusion and debridement in the surgical management of tuberculosis of the spine in patients on standard chemotherapy: a study in two centres in South Africa. *Tubercle* 1978;59(2):79–105.

151. Griffiths DL, Seddon H, Ball J, Darbyshire J *et al.* A controlled trial of short-course regimens of chemotherapy in patients receiving ambulatory treatment or undergoing radical surgery for tuberculosis of the spine. *Indian Journal of Tuberculosis* 1989;36(2 SUPPL.).

152. Strang JI, Kakaza HH, Gibson DG, Girling DJ *et al.* Controlled trial of prednisolone as adjuvant in treatment of tuberculous constrictive pericarditis in Transkei. *Lancet* 1987;2(8573):1418–1422.

153. Strang JIG, Karaza HHS, Gibson DG, Allen BW *et al.* Controlled clinical trial of complete open surgical drainage and of prednisolone in treatment of tuberculous pericardial effusion in Transkei. *Lancet* 1988;2(8614):759–764.

154. Mayosi BM, Ntsekhe M, Volmink JA, Commerford P. Interventions for treating tuberculous pericarditis. *The Cochrane Library* 2002;(4).

155. Ntsekhe M, Wiysonge C, Volmink JA, Commerford PJ, Mayosi BM. Adjuvant corticosteroids for tuberculous pericarditis: promising, but not proven. *Monthly Journal of the Association of Physicians* 2003;96(8):593–599.

156. Schrire V. Experience with pericarditis at Groote Schuur Hospital, Cape Town: an analysis of one hundred and sixty cases studied over a six-year period. *South African Medical Journal* 1959;33:810–817.

157. Hakim JG, Ternouth I, Mushangi E, Siziya S *et al.* Double blind randomised placebo controlled trial of adjunctive prednisolone in the treatment of effusive tuberculous pericarditis in HIV seropositive patients. *Heart* 2000;84(2):183–188.

158. Strang JIG. Management of tuberculous constrictive pericarditis and tuberculous pericardial effusion in Transkei: results at 10 years follow-up. *Quarterly Journal of Medicine* 2004;97(8):525–535.

159. Anadol D, Kiper N, Gocmen A, Ozcelik U. Intermittent chemotherapy for miliary tuberculosis in children. *Turkish Journal of Pediatrics* 1999;41(1):53–59.

160. Ormerod LP, Green RM, Horsfield N. Tuberculosis treatment outcome monitoring: Blackburn 1988–2000. *International Journal of Tuberculosis & Lung Disease* 2002;6(8):662–665.

161. Hayden SP, Springett VH. An assessment of the place of follow-up pulmonary tuberculosis. *British Journal of Diseases of the Chest* 1978;72(3):217–221.

162. Pearce SJ, Horne NW. Follow-up of patients with pulmonary tuberculosis adequately treated by chemotherapy: is this really necessary? *Lancet* 1974;2(7881):641–643.

163. Bailey WC, Thompson DH, Jacobs S, Ziskind M, Greenberg HB. Evaluating the need for periodic recall and re-examination of patients with inactive pulmonary tuberculosis. *American Review of Respiratory Disease* 1973;107(5):854–857.

164. Edsall J, Collins G. Routine follow-up of inactive tuberculosis, a practice to be abandoned. *American Review of Respiratory Disease* 1973;107(5):850–853.

165. Pamra SP, Prasad G, Mathur GP. Relapse in pulmonary tuberculosis. *American Review of Respiratory Disease* 1976;113(1):67–72.

166. World Health Organization. *Global tuberculosis control: surveilance, planning, financing.* Switzerland: World Health Organization, 2004.

167. Bayer R, Stayton C, Desvarieux M, Healton C *et al.* Directly observed therapy and treatment completion for tuberculosis in the United States: is universal supervised therapy necessary? *American Journal of Public Health* 1998;88(7):1052–1058.

168. Garner P. What makes DOT work? Directly observed therapy. *Lancet* 1998;352(9137):1326–1327.

169. Garner P, Volmink J. Directly observed therapy (letter). *Lancet* 1997;350(9078):666–667.

170. Chaulk CP, Kazandjian VA. Directly observed therapy for treatment completion of pulmonary tuberculosis: consensus statement of the Public Health Tuberculosis Guidelines Panel. *Journal of the American Medical Association* 1998;279(12):943–948.

171. Hill AR, Manikal VM, Riska PF. Effectiveness of directly observed therapy (DOT) for tuberculosis: a review of multinational experience reported in 1990–2000. *Medicine* 2002;81(3):179–193.

172. Volmink J, Garner P. Directly observed therapy for treating tuberculosis. *The Cochrane Library* 2003;(1).

173. MacIntyre CR, Goebel K, Brown GV, Skull S *et al.* A randomised controlled clinical trial of the efficacy of family-based direct observation of anti-tuberculosis treatment in an urban, developed-country setting. *International Journal of Tuberculosis & Lung Disease* 2003;7(9):848–854.

174. Matteelli A, Casalini C, Raviglione MC, El Hamad I *et al.* Supervised preventive therapy for latent tuberculosis infection in illegal immigrants in Italy. *American Journal of Respiratory & Critical Care Medicine* 2000;162(5):1653–1655.

175. Tandon M. DOTS versus self administered therapy (SAT) for patients of pulmonary tuberculosis: a randomised trial at a tertiary care hospital. *Indian Journal of Medical Sciences* 2002;56(1):19–21.

176. Tulsky JP, Pilote L, Hahn JA, Zolopa AJ *et al.* Adherence to isoniazid prophylaxis in the homeless: a randomized controlled trial. *Archives of Internal Medicine* 2000;160(5):697–702.

177. Chaulk P, Kazandjian VA. Comprehensive case management models for pulmonary tuberculosis. *Disease Management & Health Outcomes* 2003;11(9):571–577.

178. Kamolratanakul P. Randomized controlled trial of directly observed treatment (DOT) for patients with pulmonary tuberculosis in Thailand. *Transactions of the Royal Society of Tropical Medicine & Hygiene* 1999;93(5):552–557.

179. Walley JD, Khan MA, Newell JN, Khan MH. Effectiveness of the direct observation component of DOTS for tuberculosis: *a* randomised controlled trial in Pakistan. *Lancet* 2001;357(9257):664–669.

180. Zwarenstein M, Schoeman JH, Vundule C, Lombard CJ, Tatley M. Randomised controlled trial of self-supervised and directly observed treatment of tuberculosis. *Lancet* 1998;352(9137):1340–1343.

181. Zwarenstein M, Schoeman JH, Vundule C, Lombard CJ, Tatley M. A randomised controlled trial of lay health workers as direct observers for treatment of tuberculosis. *International Journal of Tuberculosis & Lung Disease* 2000;4(6):550–554.

182. Malotte CK, Hollingshead JR, Larro M. Incentives vs outreach workers for latent tuberculosis treatment in drug users. *American Journal of Preventive Medicine* 2001;20(2):103–107.

183. Chaisson RE, Barnes GL, Hackman J, Watkinson L *et al.* A randomized, controlled trial of interventions to improve adherence to isoniazid therapy to prevent tuberculosis in injection drug users. *American Journal of Medicine* 2001;110(8):610–615.

184. Wandwalo E, Kapalata N, Egwaga S, Morkve O. Effectiveness of community-based directly observed treatment for tuberculosis in an urban setting in Tanzania: a randomised controlled trial. *International Journal of Tuberculosis & Lung Disease* 2004;8(10):1248–1254.

185. Lwilla F, Schellenberg D, Masanja H, Acosta C *et al.* Evaluation of efficacy of community-based vs. institutional-based direct observed short-course treatment for the control of tuberculosis in Kilombero district, Tanzania. *Tropical Medicine & International Health* 2003;8(3):204–210.

186. Wright J, Walley J, Philip A, Pushpananthan S *et al.* Direct observation of treatment for tuberculosis: a randomized controlled trial of community health workers versus family members. *Tropical Medicine & International Health* 2004;9(5):559–565.

187. Mullen PD. Compliance becomes concordance. *British Medical Journal* 1997;314(7092):691–692

188. Ormerod LP. Management of pulmonary and lymph node tuberculosis notified in 1998 in England and Wales. *Clinical Medicine* 2003;3(1):57–61.

189. Fox W. Compliance of patients and physicians: experience and lessons from tuberculosis (I). *British Medical Journal* 1983;287(6384):33–35.

190. Fox W. Compliance of patients and physicians: experience and lessons from tuberculosis (II). *British Medical Journal* 1983;287(6385):101–105.

191. Volmink J, Garner P. Systematic review of randomised controlled trials of strategies to promote adherence to tuberculosis treatment. *British Medical Journal* 1997;315(7120):1403–1406.

192. Jin BW, Kim SC, Mori T, Shimao T. The impact of intensified supervisory activities on tuberculosis treatment. *Tubercle & Lung Disease* 1993;74(4):267–272.

193. Paramasivan R, Parthasarathy RT, Rajasekaran S. Short course chemotherapy: a controlled study of indirect defaulter retrieval method. *Indian Journal of Tuberculosis* 1993;40:185–190.

194. Pilote L, Tulsky JP, Zolopa AR, Hahn JA *et al.* Tuberculosis prophylaxis in the homeless: a trial to improve adherence to referral. *Archives of Internal Medicine* 1996;156(2):161–165.

195. Salleras SL, Alcaide MJ, Altet GMN, Canela SJ *et al.* Evaluation of the efficacy of health education on the compliance with antituberculosis chemoprophylaxis in school children: a randomized clinical trial. *Tubercle & Lung Disease* 1993;74(1):28–31.

196. Morisky DE, Malotte CK, Choi P *et al.* A patient education program to improve adherence rates with antituberculosis drug regimens. *Health Education Quarterly* 1990;17(3):253–267.

197. Krishnaswami KV, Somasundaram PR, Tripathy SP, Vaidyanathan B *et al.* A randomised study of two policies for managing default in out-patients collecting supplies of drugs for pulmonary tuberculosis in a large city in south India. *Tubercle* 1981;62(2):103–112.

198. Liefooghe R, Suetens C, Meulemans H, Moran MB, De Muynck A. A randomised trial of the impact of counselling on treatment adherence of tuberculosis patients in Sialkot, Pakistan. *International Journal of Tuberculosis & Lung Disease* 1999;3(12):1073–1080.

199. Moulding TS, Caymittes M. Managing medication compliance of tuberculosis patients in Haiti with medication monitors. *International Journal of Tuberculosis & Lung Disease* 2002;6(4):313–319.

200. Dick J, Lombard C. Shared vision-a health education project designed to enhance adherence to anti-tuberculosis treatment. *International Journal of Tuberculosis & Lung Disease* 1997;1(2):181–186.

201. Bock NN, Sales RM, Rogers T, DeVoe B. A spoonful of sugar...: improving adherence to tuberculosis treatment using financial incentives. *International Journal of Tuberculosis & Lung Disease* 2001;5(1):96–98.

202. Davidson H, Schluger NW, Feldman PH, Valentine DP *et al.* The effects of increasing incentives on adherence to tuberculosis directly observed therapy. *International Journal of Tuberculosis & Lung Disease* 2000;4(9):860–865.

203. Barnwell MD, Chitkara R, Lamberta F. Tuberculosis prevention project. *Journal of the National Medical Association* 1992;84(12):1014–1018.

204. Hovell MF, Sipan CL, Blumberg EJ, Hofstetter CR *et al.* Increasing Latino adolescents' adherence to treatment for latent tuberculosis infection: a controlled trial. *American Journal of Public Health* 2003;93(11):1871–1877.

205. Morisky DE, Malotte CK, Ebin V, Davidson P *et al.* Behavioral interventions for the control of tuberculosis among adolescents. *Public Health Reports* 2001;116(6):568–574.

206. White MC, Tulsky JP, Reilly P, McIntosh HW *et al.* A clinical trial of a financial incentive to go to the tuberculosis clinic for isoniazid after release from jail. *International Journal of Tuberculosis & Lung Disease* 1998;2(6):506–512.

207. Tulsky JP, Hahn JA, Long HL, Chambers DB *et al.* Can the poor adhere? Incentives for adherence to TB prevention in homeless adults. *International Journal of Tuberculosis & Lung Disease* 2004;8(1):83–91.

208. White MC, Tulsky JP, Goldenson J, Portillo CJ *et al.* Randomized controlled trial of interventions to improve follow-up for latent tuberculosis infection after release from jail. *Archives of Internal Medicine* 2002;162(9):1044–1050.

209. British Thoracic Association. A controlled trial of six months chemotherapy in pulmonary tuberculosis. First Report: results during chemotherapy. *British Journal of Diseases of the Chest* 1981;75(2):141–153.

210. Veen J, Raviglione M, Rieder HL, Migliori GB *et al.* Standardized tuberculosis treatment outcome monitoring in Europe: recommendations of a Working Group of the World Health Organization (WHO) and the European Region of the International Union Against Tuberculosis and Lung Disease (IUATLD) for uniform reporting by cohort analysis of treatment outcome in tuberculosis patients. *European Respiratory Journal* 1998;12(2):505–510.

211. White VLC, Moore-Gillon J. Resource implications of patients with multidrug resistant tuberculosis. *Thorax* 2000;55(11):962–963.

212. World Health Organization. *Anti-tuberculosis drug resistance in the world: the WHO/IUATLD Global Project on Anti-Tuberculosis Dug Resistance Surveillance.* Geneva: World Health Organization, 2004.

213. Djuretic T, Herbert J, Drobniewski F, Yates M *et al.* Antibiotic resistant tuberculosis in the United Kingdom:1993–1999. *Thorax* 2002;57(6):477–482.

214. Al Jarad N, Parastatides S, Paul EA, Sheldon CD *et al.* Characteristics of patients with drug resistant and drug sensitive tuberculosis in East London between 1984 and 1992. *Thorax* 1994;49(8):808–810.

215. Pritchard AJ, Hayward AC, Monk PN, Neal KR. Risk factors for drug resistant tuberculosis in Leicestershire-poor adherence to treatment remains an important cause of resistance. *Epidemiology & Infection* 2003;130(3):481–483.

216. Conaty SJ, Hayward AC. Explaining risk factors for drug resistant tuberculosis in England and Wales: contribution of primary and secondary drug resistance. *Epidemiology & Infection* 2004;132:1099–1108.

217. Anastasis D, Pillai G, Rambiritch V, Abdool Karim SS. A retrospective study of human immunodeficiency virus infection and drug-resistant tuberculosis in Durban, South Africa. *International Journal of Tuberculosis & Lung Disease* 1997;1(3):220–224.

218. Githui WA, Juma ES, Van Gorkom J, Kibuga D *et al.* Antituberculosis drug resistance surveillance in Kenya, 1995. *International Journal of Tuberculosis & Lung Disease* 1998;2(6):499–505.

219. Weyer K, Groenewald P, Zwarenstein M, Lombard CJ. Tuberculosis drug resistance in the Western Cape. *South African Medical Journal* 1995;85(6):499–504.

220. Wilkinson D, Pillay M, Davies GR, Sturm AW. Resistance to antituberculosis drugs in rural South Africa: rates, patterns, risks, and transmission dynamics. *Transactions of the Royal Society of Tropical Medicine & Hygiene* 1996;90(6):692–695.

221. Moore M, Onorato IM, McCray E, Castro KG. Trends in drug-resistant tuberculosis in the United States, 1993–1996. *Journal of the American Medical Association* 1997;278(10):833–837.

222. Robert J, Trystram D, Truffot-Pernot C, Carbonnelle B, Grosset J. Surveillance of *Mycobacterium tuberculosis* drug resistance in France, 1995–1997. AZAY Mycobacteria Study Group. *International Journal of Tuberculosis & Lung Disease* 2000;4(7):665–672.

223. Lambregts-Van Weezenbeek CSB, Jansen HM, Nagelkerke NJD, Van Klingeren B, Veen J. Nationwide surveillance of drug-resistant tuberculosis in the Netherlands: rates, risk factors and treatment outcome. *International Journal of Tuberculosis & Lung Disease* 1998;2(4):288–295.

224. Helbling P, Altpeter E, Raeber PA, Pfyffer GE, Zellweger JP. Surveillance of antituberculosis drug resistance in Switzerland 1995–1997: the central link. *European Respiratory Journal* 2000;16(2):200–202.

225. Sharma SK, Turaga KK, Balamurugan A, Saha PK *et al.* Clinical and genetic risk factors for the development of multi-drug resistant tuberculosis in non-HIV infected patients at a tertiary care center in India: a case-control study. *Infection, Genetics & Evolution* 2003;3(3):183–188.

226. Salomon N, Perlman DC, Friedmann P, Buchstein S *et al.* Predictors and outcome of multidrug-resistant tuberculosis. *Clinical Infectious Diseases* 1995;21(5):1245–1252.

227. Goble M, Iseman MD, Madsen LA, Waite D *et al.* Treatment of 171 patients with pulmonary tuberculosis resistant to isoniazid and rifampin. *New England Journal of Medicine* 1993;328(8):527–532.

228. Telzak EE, Sepkowitz K, Alpert P, Mannheimer S *et al.* Multidrug-resistant tuberculosis in patients without HIV infection. *New England Journal of Medicine* 1995;333(14):907–911.

229. Herrera D. Multidrug-resistant tuberculosis outbreak on an HIV ward-Madrid, Spain, 1991–1995. *Morbidity & Mortality Weekly Report* 1996;45(16):330–333.

230. Chan ED, Laurel V, Strand MJ, Chan JF *et al.* Treatment and outcome analysis of 205 patients with multidrug-resistant tuberculosis. *American Journal of Respiratory & Critical Care Medicine* 2004;169(10): 1103–1109.

231. Narita M, Alonso P, Lauzardo M, Hollender ES *et al.* Treatment experience of multidrug-resistant tuberculosis in Florida, 1994–1997. *Chest* 2001;120(2):343–348.

232. Breathnach AS, de Ruiter A, Holdsworth GM, Bateman NT *et al.* An outbreak of multi-drug-resistant tuberculosis in a London teaching hospital. *Journal of Hospital Infection* 1998;39(2):111–117.

233. Maloney SA, Pearson ML, Gordon MT, Del Castillo R *et al.* Efficacy of control measures in preventing nosocomial transmission of multidrug-resistant tuberculosis to patients and health care workers. *Annals of Internal Medicine* 1995;122(2):90–95.

234. Stroud LA, Tokars JI, Grieco MH, Crawford JT *et al.* Evaluation of infection control measures in preventing the nosocomial transmission of multidrug-resistant *Mycobacterium tuberculosis* in a New York City hospital. *Infection Control & Hospital Epidemiology* 1995;16(3):141–147.

235. Wenger PN, Otten J, Breeden A, Orfas D *et al.* Control of nosocomical transmission of multidrug-resistant *Mycobacterium tuberculosis* among healthcare workers and HIV-infected patients. *Lancet* 1995;345(8944):235–240.

236. Smieja MJ, Marchetti CA, Cook DJ, Smaill FM. Isoniazid for preventing tuberculosis in non-HIV infected persons. *The Cochrane Library* 1999;(1).

237. Girling DJ, Chan SL. A double-blind placebo-controlled clinical trial of three antituberculosis chemoprophylaxis regimens in patients with silicosis in Hong Kong. *American Review of Respiratory Disease* 1992;145:36–41.

238. Thompson NJ. Efficacy of various durations of isoniazid preventive therapy for tuberculosis: five years of follow-up in the IUAT trial. International Union Against Tuberculosis Committee on Prophylaxis. *Bulletin of the World Health Organization* 1982;60(4):555–564.

239. Jasmer RM, Saukkonen JJ, Blumberg HM, Daley CL *et al.* Short-course rifampin and pyrazinamide compared with isoniazid for latent tuberculosis infection: a multicenter clinical trial. *Annals of Internal Medicine* 2002;137(8):640–647.

240. McNeill L, Allen M, Estrada C, Cook P. Pyrazinamide and rifampin vs isoniazid for the treatment of latent tuberculosis: improved completion rates but more hepatotoxicity. *Chest* 2003;123(1):102–106.

241. Leung CC, Law WS, Chang KC, Tam CM *et al.* Initial experience on rifampin and pyrazinamide vs isoniazid in the treatment of latent tuberculosis infection among patients with silicosis in Hong Kong. *Chest* 2003;124(6):2112–2118.

242. Gupta DK, Kumar R, Nath N, Kothari AK. Chemoprophylaxis in high risk children-analysis of 8 years' follow up: preliminary report. *Indian Journal of Tuberculosis* 1993;40:125–127.

243. Ormerod LP. Rifampicin and isoniazid prophylactic chemotherapy for tuberculosis. *Archives of Disease in Childhood* 1998;78(2):169–171.

244. Bucher HC, Griffith LE, Guyatt GH, Sudre P *et al.* Isoniazid prophylaxis for tuberculosis in HIV infection: a meta-analysis of randomized controlled trials. *AIDS* 1999;13(4):501–507.

245. Wilkinson D, Squire SB, Garner P. Effect of preventive treatment for tuberculosis in adults infected with HIV: systematic review of randomised placebo controlled trials. *British Medical Journal* 1998;317(7159):625–629.

246. Woldehanna S, Volmink J. Treatment of latent tuberculosis infection in HIV infected persons. *The Cochrane Library* 2004;(1):CD0001171.

247. Wilkinson D. Drugs for preventing tuberculosis in HIV infected persons. *The Cochrane Library* 2000;(4).

248. American Thoracic Society and the Centers for Disease Control and Prevention. Targeted tuberculin testing and treatment of latent tuberculosis infection. *American Journal of Respiratory & Critical Care Medicine* 2000;161(4 Pt 2):S221–S247.

249. Fatal and severe hepatitis associated with rifampin and pyrazinamide for the treatment of latent tuberculosis infection – New York and Georgia, 2000. *Morbidity & Mortality Weekly Report* 2001;50(15):289–291.

250. American Thoracic Society and the Centers for Disease Control and Prevention. Fatal and severe liver injuries associated with rifampin and pyrazinamide for latent tuberculosis infection *Morbidity & Mortality Weekly Report* 2001;50(34):733–735.

251. Lee AM, Mennone JZ, Jones RC, Paul WS. Risk factors for hepatotoxicity associated with rifampin and pyrazinamide for the treatment of latent tuberculosis infection: experience from three public health tuberculosis clinics. *International Journal of Tuberculosis & Lung Disease* 2002;6(11):995–1000.

252. Enarson DA. 'The epidemiological basis of tuberculosis control'. In: *Clinical tuberculosis.* London, Chapman & Hall, 1998.

253. Dye C, Scheele S, Dolin P, Pathania V, Raviglione MC. Global burden of tuberculosis: estimated incidence, prevalence, and mortality by country. WHO Global Surveillance and Monitoring Project. *Journal of the American Medical Association* 1999;282(7):677–686.

254. Cohn DL, El Sadr WM. 'Treatment of latent tuberculosis infection'. In: *Tuberculosis: a comprehensive international approach. Second ed.* New York: Marcel Dekker, 2000.

255. Selwyn PA, Hartel D, Lewis VA, Schoenbaum EE *et al.* A prospective study of the risk of tuberculosis among intravenous drug users with human immunodeficiency virus infection. *New England Journal of Medicine* 1989;320(9):545–550.

256. Ferebee SH. Controlled chemoprophylaxis trials in tuberculosis: a general review. *Bibliotheca Tuberculosea* 1970;26:28–106.

257. Sutherland I, Svandova E, Radhakrishna S. The development of clinical tuberculosis following infection with tubercle bacilli. *Tubercle* 1982;63(4):255–268.

258. Falk A, Fuchs GF. Prophylaxis with isoniazid in inactive tuberculosis: a veterans administration cooperative study XII. *Chest* 1978;73(1):44–48.

259. Steinbruck P, Dankova D, Edwards LB, Doster B, Livesay VT. The risk of tuberculosis in patients with fibrous lesions radiologically diagnosed [French]. *Bulletin of the International Union Against Tuberculosis* 1972;47:144–171.

260. Palmer C, Jablon S, Edwards P. Tuberculosis morbidity of young men in relation to tuberculin sensitivity and body build. *American Review of Tuberculosis* 1957;76(4):517–539.

261. Lichtenstein IH, MacGregor RR. Mycobacterial infections in renal transplant recipients: report of five cases and review of the literature. *Review of Infectious Diseases* 1983;5(2):216–226.

262. Munoz P, Palomo J, Munoz R, Rodriguez-Creixems M *et al.* Tuberculosis in heart transplant recipients. *Clinical Infectious Diseases* 1995;21(2):398–402.

263. Korner MM, Hirata N, Tenderich G, Minami K *et al.* Tuberculosis in heart transplant recipients. *Chest* 1997;111(2):365–369.

264. Pickleman JR, Evans LS, Kane JM, Freeark RJ. Tuberculosis after jejunoileal bypass for obesity. *Journal of the American Medical Association* 1975;234(7):744.

265. Bruce RM, Wise L. Tuberculosis after jejunoileal bypass for obesity. *Annals of Internal Medicine* 1977;87(5):574–576.

266. Paul R. Silicosis in Northern Rhodesia copper miners. *Archives of Environmental Health* 1961;2:96–109.

267. Lundin AP, Adler AJ, Berlyne GM, Friedman EA. Tuberculosis in patients undergoing maintenance hemodialysis. *American Journal of Medicine* 1979;67(4):597–602.

268. Chia S, Karim M, Elwood RK, FitzGerald JM. Risk of tuberculosis in dialysis patients: a population-based study. *International Journal of Tuberculosis & Lung Disease* 1998;2(12):989–991.

269. Andrew OT, Schoenfeld PY, Hopewell PC, Humphreys MH. Tuberculosis in patients with end-stage renal disease. *American Journal of Medicine* 1980;68(1):59–65.

270. Thorn P, Brookes V, Waterhouse J. Peptic ulcer, partial gastrectomy, and pulmonary tuberculosis. *British Medical Journal* 1956;(4967):603–608.

271. Snider DE. Tuberculosis and gastrectomy. *Chest* 1985;87(4):414–415.

272. Steiger Z, Nickel WO, Shannon GJ, Nedwicki EG, Higgins RF. Pulmonary tuberculosis after gastric resection. *American Journal of Surgery* 1976;131(6):668–671.

273. Pablos-Mendez A, Blustein J, Knirsch CA. The role of diabetes mellitus in the higher prevalence of tuberculosis among Hispanics. *American Journal of Public Health* 1997;87(4):574–579.

274. Boucot K, Dillon E, Cooper D, Meier P, Richardson R. Tuberculosis among diabetics: the Philadelphia survey. *American Review of Tuberculosis* 1952;65(1:2):1–50.

275. Oscarsson PN, Silwar H. Incidence of pulmonary tubereculosis among diabetics: search among diabetics in the county of Kristianstad. *Acta Medica Scandinavia* 1958;161(Suppl 335):23–48.

276. Keane J, Gershon S, Wise RP, Mirabile-Levens E *et al.* Tuberculosis associated with infliximab, a tumor necrosis factor alpha-neutralizing agent. *New England Journal of Medicine* 2001;345(15):1098–1104.

277. Wolfe F, Michaud K, Anderson J, Urbansky K. Tuberculosis infection in patients with rheumatoid arthritis and the effect of infliximab therapy. *Arthritis & Rheumatism* 2004;50(2):372–379.

278. The British Thoracic Association. A study of a standardised contact procedure in tuberculosis. *Tubercle* 1978;59(4):245–259.

279. Milstien JB, Gibson JJ. Quality control of BCG vaccine by WHO: a review of factors that may influence vaccine effectiveness and safety. *Bulletin of the World Health Organization* 1990;68(1):93–108.

280. Fine PE. Bacille Calmette-Guerin vaccines: a rough guide. *Clinical Infectious Diseases* 1995;20(1):11–14.

281. Wilson ME, Fineberg HV, Colditz GA. Geographic latitude and the efficacy of bacillus Calmette-Guerin vaccine. *Clinical Infectious Diseases* 1995;20(4):982–991.

282. Trial of BCG vaccines in south India for tuberculosis prevention: first report – Tuberculosis Prevention Trial. *Bulletin of the World Health Organization* 1979;57(5):819–827.

283. Packe GE, Innes JA. Protective effect of BCG vaccination in infant Asians: a case control study. *Archives of Disease in Childhood* 1988;63(3):277–281.

284. Hart PD, Surtherland I, Thomas J. The immunity conferred by effective BCG and vole bacillus vaccines, in relation to individual variations in induced tuberculin sensitivity and to technical variations in the vaccines. *Tubercle* 1967;48:201–210.

285. Hart PD, Sutherland I. BCG and vole bacillus vaccines in the prevention of tuberculosis in adolescence and early adult life: final report to the Medical Research Council. *British Medical Journal* 1977;2(6082):293–295.

286. Aronson NE, Santosham M, Comstock GW, Howard RS *et al.* Long-term efficacy of BCG vaccine in American Indians and Alaska Natives: a 60-year follow-up study. *Journal of the American Medical Association* 2004;291(17):2086–2091.

287. Joseph CA, Watson JM, Fern KJ. BCG immunisation in England and Wales: a survey of policy and practice in schoolchildren and neonates. *British Medical Journal* 1992;305(6852):495–498.

288. Colditz GA, Berkey CS, Mosteller F, Brewer TF *et al.* The efficacy of bacillus Calmette-Guerin vaccination of newborns and infants in the prevention of tuberculosis: meta-analyses of the published literature. *Pediatrics* 1995;96(1:Pt 1):29–35.

289. Wasz-Hockert O, Genz H, Landmann H, Ocklitz HW. The effects of systematic BCG vaccination of newborn on the incidence of post-primary tuberculous meningitis in childhood. *Padiatrie und Grenzgebiete* 1989;28(6):365–370.

290. Altet Gomez MN, Alcaide MJ, Canela SJ, Serra ML, Salleras SL. Retrospective evaluation of the efficacy of the BCG vaccination campaign of newborns in Barcelona, Spain. *Tubercle & Lung Disease* 1993;74(2):100–105.

291. Criteria for discontinuation of vaccination programmes using Bacille Calmette-Guerin (BCG) in countries with a low prevalence of tuberculosis: a statement of the International Union Against Tuberculosis and Lung Disease. *Tubercle & Lung Disease* 1994;75(3):179–180.

292. Sutherland I. Effectiveness of BCG vaccination in England and Wales in 1983. *Tubercle* 1987;68(2): 81–92.

293. Sutherland I, Springett VH. The effects of the scheme for BCG vaccination of schoolchildren in England and Wales and the consequences of discontinuing the scheme at various dates. *Journal of Epidemiology & Community Health* 1989;43(1):15–24.

294. Ormerod LP, Charlett A, Gilham C, Darbyshire JH, Watson JM. Geographical distribution of tuberculosis notifications in national surveys of England and Wales in 1988 and 1993: report of the Public Health Laboratory Service/British Thoracic Society/Department of Health Collaborative Group. *Thorax* 1998;53(3):176–181.

295. Saeed M, Reid A, Nichols T, Rose AMC *et al. An update of the effect of a schools' BCG programme in England and Wales.* London: Health Protection Agency, 2002

296. Ormerod LP. Is new immigrant screening for tuberculosis still worthwhile? *Journal of Infection* 1998; 37(1):39–40.

297. Ormerod LP. Tuberculosis screening and prevention in new immigrants 1983–88. *Respiratory Medicine* 1990;84(4):269–271.

298. Colditz GA, Brewer TF, Berkey CS, Wilson ME *et al.* Efficacy of BCG vaccine in the prevention of tuberculosis: meta-analysis of the published literature. *Journal of the American Medical Association* 1994;271(9):698–702.

299. Chaloner JH, Ormerod LP. Assessment of the impact of BCG vaccination on tuberculosis incidence in south Asian adult immigrants. *Communicable Disease & Public Health* 2002;5(4):338–340.

300. Meredith S, Watson JM, Citron KM, Cockcroft A, Darbyshire JH. Are healthcare workers in England and Wales at increased risk of tuberculosis? *British Medical Journal* 1996;313(7056):522–525.

301. Brewer TF, Colditz GA. Bacille Calmette-Guerin vaccination for the prevention of tuberculosis in health care workers. *Clinical Infectious Diseases* 1995;20(1):136–142.

302. Jin BW, Hong YP, Kim SJ. A contact study to evaluate the BCG vaccination programme in Seoul. *Tubercle* 1989;70(4):241–248.

303. Capewell S, Leitch AG. The value of contact procedures for tuberculosis in Edinburgh. *British Journal of Diseases of the Chest* 1984;78(4):317–329.

304. Rubilar M, Brochwicz-Lewinski MJ, Anderson M, Leitch AG. The outcome of contact procedures for tuberculosis in Edinburgh, Scotland 1982–1991. *Respiratory Medicine* 1995;89(2):113–120.

305. Kritski AL, Marques MJ, Rabahi MF, Vieira MA *et al.* Transmission of tuberculosis to close contacts of patients with multidrug-resistant tuberculosis. *American Journal of Respiratory & Critical Care Medicine* 1996;153(1):331–335.

306. Esmonde TF, Petheram IS. Audit of tuberculosis contact tracing procedures in south Gwent. *Respiratory Medicine* 1991;85(5):421–424.

307. Hussain SF, Watura R, Cashman B, Campbell IA, Evans MR. Tuberculosis contact tracing: are the British Thoracic Society guidelines still appropriate? *Thorax* 1992;47(11):984–985.

308. Kumar S, Innes JA, Skinner C. Yield from tuberculosis contact tracing in Birmingham. *Thorax* 1992; 47:875.

309. Ormerod LP. Tuberculosis contact tracing. Blackburn 1982–90. *Respiratory Medicine* 1992;87(2):127–131.

310. Teale C, Cundall DB, Pearson SB. Time of development of tuberculosis in contacts. *Respiratory Medicine* 1991;85(6):475–477.

311. Ansari S, Thomas S, Campbell IA, Furness L, Evans MR. Refined tuberculosis contact tracing in a low incidence area. *Respiratory Medicine* 1998;92(9):1127–1131.

312. Hardinge FM, Black M, Chamberlain P. TB contact tracing in South Buckinghamshire from 1994 to mid 1998. *American Journal of Respiratory & Critical Care Medicine* 1999;159(Suppl): a303.

313. Irish C, Jolly E, Baker T. Contact tracing smear negative and non-pulmonary tuberculosis in a high incidence area. *Thorax* 1997;52(Suppl 6): a34.

314. Behr MA, Warren SA, Salamon H, Hopewell PC *et al.* Transmission of *Mycobacterium tuberculosis* from patients smear-negative for acid-fast bacilli. *Lancet* 1999;353(9151):444–449.

315. Hernandez-Garduno E, Cook V, Kinimoto D, Elwood RK, Black WA. Transmission of tuberculosis from smear-negative patients: a molecular epidemiology study. *Thorax* 2004;59(4):286–290.

316. Grzybowski S, Barnett GD, Styblo K. Contacts of cases of active pulmonary tuberculosis. *Bulletin of the International Union Against Tuberculosis* 1975;50(1):90–106.

317. Lobato MN, Royce SE, Mohle-Boetani JC. Yield of source-case and contact investigations in identifying previously undiagnosed childhood tuberculosis. *International Journal of Tuberculosis & Lung Disease* 2003;7(12 Suppl. 3):S391–S396.

318. Driver CR, Cordova IM, Munsiff SS. Targeting tuberculosis testing: the yield of source case investigations for young children with reactive tuberculin skin tests. *Public Health Reports* 2002;117(4):366–372.

319. Reichler MR, Reves R, Bur S, Thompson V *et al.* Evaluation of investigations conducted to detect and prevent transmission of tuberculosis. *Journal of the American Medical Association* 2002;287(8):991–995.

320. Liippo KK, Kulmala K, Tala EO. Focusing tuberculosis contact tracing by smear grading of index cases. *American Review of Respiratory Disease* 1993;148(1):235–236.

321. Hussain SF, Watura R, Cashman B, Campbell IA, Evans MR. Audit of a tuberculosis contact tracing clinic. *British Medical Journal* 1992;304(6836):1213–1215.

322. Del Castillo OD, Penafiel CM, Alvarez GF, Soto Campos JG, *et al.* Investigation of tuberculosis contacts in a nonhospital pneumology practice. *European Journal of Clinical Microbiology & Infectious Diseases* 1999;18(11):790–795.

323. Li J, Driver CR, Munsiff SS, Fujiwara PI. Finding contacts of homeless tuberculosis patients in New York City. *International Journal of Tuberculosis & Lung Disease* 2003;7(12 Suppl.3):S397–S404.

324. van Deutekom H, Hoijng SP, de Haas PE, Langendam MW *et al.* Clustered tuberculosis cases: do they represent recent transmission and can they be detected earlier? *American Journal of Respiratory & Critical Care Medicine* 2004;169(7):806–810.

325. Nitta AT, Knowles LS, Kim J, Lehnkering EL *et al.* Limited transmission of multidrug-resistant tuberculosis despite a high proportion of infectious cases in Los Angeles County, California. *American Journal of Respiratory & Critical Care Medicine* 2002;165(6):812–817.

326. Bishai WR, Graham NM, Harrington S, Pope DS *et al.* Molecular and geographic patterns of tuberculosis transmission after 15 years of directly observed therapy. *Journal of the American Medical Association* 1998;280(19):1679–1684.

327. Barnes PF, Yang Z, Preston-Martin S, Pogoda JM *et al.* Patterns of tuberculosis transmission in Central Los Angeles. *Journal of the American Medical Association* 1997;278(14):1159–1163.

328. Solsona J, Cayla JA, Verdu E, Estrada MP *et al.* Molecular and conventional epidemiology of tuberculosis in an inner city district. *International Journal of Tuberculosis & Lung Disease* 2001;5(8):724–731.

329. Ruddy MC, Davies AP, Yates MD, Yates S *et al.* Outbreak of isoniazid resistant tuberculosis in north London. *Thorax* 2004;59(4):279–285.

330. Veen J. Microepidemics of tuberculosis: the stone-in-the-pond principle. *Tubercle & Lung Disease* 1992;73(2):73–76.

331. PHLS. Enhanced surveillance of *Mycobacterium bovis* in humans. *Communicable Disease Weekly* 1998; 8(32):281–284.

332. Department of Health. *Bovine Tuberculosis guidance on management of the public health consequences of tuberculosis in cattle in England and Wales.* London: DH, 2000.

333. Lobue PA, LeClair JJ, Moser KS. Contact investigation for cases of pulmonary *Mycobacterium bovis*. *International Journal of Tuberculosis & Lung Disease* 2004;8(7):868–872.

334. Driver CR, Valway SE, Morgan WM, Onorato IM, Castro KG. Transmission of *Mycobacterium tuberculosis* associated with air travel. *Journal of the American Medical Association* 1994;272(13):1031–1035.

335. Whitlock G, Calder L, Perry H. A case of infectious tuberculosis on two long-haul aircraft flights: contact investigation. *New Zealand Medical Journal* 2001;114(1137):353–355.

336. Wang PD. Two-step tuberculin testing of passengers and crew on a commercial airplane. *American Journal of Infection Control* 2000;28(3):233–238.

337. Kenyon TA, Valway SE, Ihle WW, Onorato IM, Castro KG. Transmission of multi-drug-resistant *Mycobacterium tuberculosis* during a long airplane flight. *New England Journal of Medicine* 1996;334(15): 933–938.

338. Miller MA, Valway S, Onorato IM. Tuberculosis risk after exposure on airplanes. *Tubercle & Lung Disease* 1996;77(5):414–419.

339. Moore M, Fleming KS, Sands L. A passenger with pulmonary/laryngeal tuberculosis: no evidence of transmission on two short flights. *Aviation Space & Environmental Medicine* 1996;67(11):1097–1100.

340. Curtis AB, Ridzon R, Vogel R, McDonough S *et al.* Extensive transmission of *Mycobacterium tuberculosis* from a child. *New England Journal of Medicine* 1999;341(20):1491–1495.

341. Phillips L, Carlile J, Smith D. Epidemiology of a tuberculosis outbreak in a rural Missouri high school. *Pediatrics* 2004;113(6):e514–e519.

342. Ridzon R, Kent JH, Valway S, Weismuller P *et al.* Outbreak of drug-resistant tuberculosis with second-generation transmission in a high school in California. *Journal of Pediatrics* 1997;131(6):863–868.

343. The Lodi Tuberculosis Working Group. A school and community-based outbreak of *Mycobacterium tuberculosis* in northern Italy, 1992–3. *Epidemiology & Infection* 1994;113(1):83–93.

344. Rothman LM, Dubeski G. School contact tracing following a cluster of tuberculosis cases in two Scarborough schools. Canadian Journal of Public Health Revue 1993;84(5):297–302.

345. Sacks JJ, Brenner ER, Breeden DC, Anders HM, Parker RL. Epidemiology of a tuberculosis outbreak in a South Carolina junior high school. *American Journal of Public Health* 1985;75(4):361–365.

346. Calder L, Hampton L, Prentice D, Reeve M *et al.* A school and community outbreak of tuberculosis in Auckland. *New Zealand Medical Journal* 2000;113(1105):71–74.

347. Connolly K, Murphy C. A school outbreak of tuberculosis. *Irish Medical Journal* 1987;80(12):415.

348. Wales JM, Buchan AR, Cookson JB, Jones DA, Marshall BS. Tuberculosis in a primary school: the Uppingham outbreak. *British Medical Journal* (clinical research ed) 1985;291(6501):1039–1040.

349. Light IJ, Saidleman M, Sutherland JM. Management of newborns after nursery exposure to tuberculosis. *American Review of Respiratory Disease* 1974;109(4):415–419.

350. Agata E-MC, Wise S, Stewart A, Lefkowitz LB, Jr. Nosocomial transmission of *Mycobacterium tuberculosis* from an extrapulmonary site. *Infection Control & Hospital Epidemiology* 2001;22(1):10–12.

351. Drobniewski FA, Ferguson J, Barritt K, Higgins RM *et al.* Follow up of an immunocompromised contact group of a case of open pulmonary tuberculosis on a renal unit. *Thorax* 1995;50(8):863–868.

352. Zaza S, Blumberg HM, Beck-Sague C, Haas WH *et al.* Nosocomial transmission of *Mycobacterium tuberculosis*: role of health care workers in outbreak propagation. *Journal of Infectious Diseases* 1995; 172(6):1542–1549.

353. Zaza S, Beck-Sague CM, Jarvis WR. Tracing patients exposed to health care workers with tuberculosis. *Public Health Reports* 1997;112(2):153–157.

354. George RH, Gully PR, Gill ON, Innes JA *et al.* An outbreak of tuberculosis in a children's hospital. *Journal of Hospital Infection* 1986;8(2):129–142.

355. Medical Research Council Tuberculosis and Chest Diseases Unit. National survey of tuberculosis notifications in England and Wales 1978–9. *British Medical Journal* 1980;281(6245):895–898.

356. Bothamley GH, Rowan JP, Griffiths CJ, Beeks M *et al.* Screening for tuberculosis: the port of arrival scheme compared with screening in general practice and the homeless. *Thorax* 2002;57(1):45–49.

357. Verver S, Bwire R, Borgdorff MW. Screening for pulmonary tuberculosis among immigrants: estimated effect on severity of disease and duration of infectiousness. *International Journal of Tuberculosis & Lung Disease* 2001;5(5):419–425.

358. El Hamad I, Casalini C, Matteelli A, Casari S *et al.* Screening for tuberculosis and latent tuberculosis infection among undocumented immigrants at an unspecialised health service unit. *International Journal of Tuberculosis & Lung Disease* 2001;5(8):712–716.

359. Kelly PM, Scott L, Krause VL. Tuberculosis in East Timorese refugees: implications for health care needs in East Timor. *International Journal of Tuberculosis & Lung Disease* 2002;6(11):980–987.

360. Truong DH, Hedemark LL, Mickman JK, Mosher LB *et al.* Tuberculosis among Tibetan immigrants from India and Nepal in Minnesota, 1992-1995. *Journal of the American Medical Association* 1997;277(9): 735–738.

361. Nolan CM, Elarth AM. Tuberculosis in a cohort of South East Asian Refugees. A five-year surveillance study. *American Review of Respiratory Disease* 1988;137(4):805–809.

362. Capewell S, France AJ, Anderson M, Leitch AG. The diagnosis and management of tuberculosis in common hostel dwellers. *Tubercle* 1986;67(2):125–131.

363. Patel KR. Pulmonary tuberculosis in residents of lodging houses, night shelters and common hostels in Glasgow: a 5-year prospective survey. *British Journal of Diseases of the Chest* 1985;79(1):60–66.

364. Kumar D, Citron KM, Leese J, Watson JM. Tuberculosis among the homeless at a temporary shelter in London: report of a chest x ray screening programme. *Journal of Epidemiology & Community Health* 1995;49(6):629–633.

365. Griffin RG, Hoff GL. Tuberculosis screening in Kansas City homeless shelters. *Missouri Medicine* 1999;96(10):496–499.

366. Kermode M, Crofts N, Miller P, Speed B, Streeton J. Health indicators and risks among people experiencing homelessness in Melbourne, 1995–1996. *Australian & New Zealand Journal of Public Health* 1998;22(4):464–470.

367. Southern A, Premaratne N, English M, Balazs J, O'Sullivan D. Tuberculosis among homeless people in London: an effective model of screening and treatment. *International Journal of Tuberculosis & Lung Disease* 1999;3(11):1001–1008.

368. Layton MC, Cantwell MF, Dorsinville GJ, Valway SE *et al.* Tuberculosis screening among homeless persons with AIDS living in single-room-occupancy hotels. *American Journal of Public Health* 1995; 85(11):1556–1559.

369. Lunn JA, Mayho V. Incidence of pulmonary tuberculosis by occupation of hospital employees in the National Health Service in England and Wales 1980–84. *Journal of the Society of Occupational Medicine* 1989;39(1):30–32.

370. Hill A, Burge A, Skinner C. Tuberculosis in NHS hospital staff in the west Midlands region of England, 1992–5. *Thorax* 1997;52(11):994–997.

371. Wiggam SL, Hayward AC. Hospitals in England are failing to follow guidance for tuberculosis infection control – results of a National Survey. *Journal of Hospital Infection* 2000;46(4):257–262.

372. Bangsberg DR, Crowley K, Moss A, Dobkin JF *et al.* Reduction in tuberculin skin-test conversions among medical house staff associated with improved tuberculosis infection control practices. *Infection Control & Hospital Epidemiology* 1997;18(8):566–570.

373. Blumberg HM, Watkins DL, Berschling JD, Antle A *et al.* Preventing the nosocomial transmission of tuberculosis. *Annals of Internal Medicine* 1995;122(9):658–663.

374. Fella P, Rivera P, Hale M, Squires K, Sepkowitz K. Dramatic decrease in tuberculin skin test conversion rate among employees at a hospital in New York City. *American Journal of Infection Control* 1995;23(6):352–356.

375. Jereb JA, Klevens RM, Privett TD, Smith PJ *et al.* Tuberculosis in health care workers at a hospital with an outbreak of multidrug-resistant *Mycobacterium tuberculosis*. *Archives of Internal Medicine* 1995;155(8):854–859.

376. Behrman AJ, Shofer FS. Tuberculosis exposure and control in an urban emergency department. *Annals of Emergency Medicine* 1998;31(3):370–375.

377. Menzies D, Fanning A, Yuan L, FitzGerald JM. Hospital ventilation and risk for tuberculous infection in Canadian health care workers. Canadian Collaborative Group in Nosocomial Transmission of TB. *Annals of Internal Medicine* 2000;133(10):779–789.

378. Singh D, Sutton C, Woodcock A. Repeat tuberculin testing in BCG-vaccinated subjects in the United Kingdom. The booster effect varies with the time of reading. *American Journal of Respiratory & Critical Care Medicine* 2001;164(6):962–964.

379. Nursing and Midwifery Council. *The NMC Code of Professional Conduct: standards for conduct, performance and ethics.* London: NMC, 2004

380. Darbyshire JH. Tuberculosis in prisons. *British Medical Journal* 1989;299(6704):874.

381. Bock NN, Reeves M, LaMarre M, DeVoe B. Tuberculosis case detection in a state prison system. *Public Health Reports* 1998;113(4):359–364.

382. Saunders DL, Olive DM, Wallace SB, Lacy D *et al.* Tuberculosis screening in the federal prison system: an opportunity to treat and prevent tuberculosis in foreign-born populations. *Public Health Reports* 2001;116(3):210–218.

383. Klopf LC. Tuberculosis control in the New York State Department of Correctional Services: a case management approach. *American Journal of Infection Control* 1998;26(5):534–537.

384. Puisis M, Feinglass J, Lidow E, Mansour M. Radiographic screening for tuberculosis in a large urban county jail. *Public Health Reports* 1996;111(4):330–334.

385. Health and Safety Executive. *Respiratory protective equipment at work: a practical guide HSG53.* Sudbury: HSE Books, 2005. Available from **www.hsebooks.com/Books/**

386. Interdepartmental Working Group on Tuberculosis. *The prevention and control of tuberculosis in the United Kingdom: UK guidance on the prevention and control of transmission of 1. HIV-related tuberculosis 2. drug-resistant, including multiple drug-resistant, tuberculosis.* London: Department of Health, 1998.

16.1 References 2011

Anon Hospital Episode Statistics 2003: Provided data used in section 11 (Internet download)

Adetifa IM, Lugos MD, Hammond A et al. (2007) Comparison of two interferon gamma release assays in the diagnosis of Mycobacterium tuberculosis infection and disease in The Gambia. BMC Infectious Diseases 7: 122.

Alvarez-Leon EE, Espinosa-Vega E, Santana-Rodriguez E et al. (2009) Screening for tuberculosis infection in spanish healthcare workers: Comparison of the QuantiFERON-TB gold in-tube test with the tuberculin skin test. Infection Control & Hospital Epidemiology 30: 876-83.

Arend SM, Thijsen SF, Leyten EM et al. (2007) Comparison of two interferon-gamma assays and tuberculin skin test for tracing tuberculosis contacts.[see comment]. American Journal of Respiratory & Critical Care Medicine 175: 618-27.

Balcells ME, Perez CM, Chanqueo L et al. (2008) A comparative study of two different methods for the detection of latent tuberculosis in HIV-positive individuals in Chile. International Journal of Infectious Diseases 12: 645-52.

Bartalesi F, Vicidomini S, Goletti D et al. (2009) QuantiFERON-TB Gold and the TST are both useful for latent tuberculosis infection screening in autoimmune diseases. European Respiratory Journal 33: 586-93.

Brock I, Weldingh K, Lillebaek T et al. (2004) Comparison of tuberculin skin test and new specific blood test in tuberculosis contacts.[see comment]. American Journal of Respiratory & Critical Care Medicine 170: 65-9.

Brodie D, Lederer DJ, Gallardo JS et al. (2008) Use of an interferon-gamma release assay to diagnose latent tuberculosis infection in foreign-born patients. Chest 133: 869-74.

Casas I, Latorre I, Esteve M et al. (2009) Evaluation of interferon-gamma release assays in the diagnosis of recent tuberculosis infection in health care workers. PLoS ONE [Electronic Resource] 4: e6686.

Chun JK, Kim CK, Kim HS et al. (2008) The role of a whole blood interferon-gamma assay for the detection of latent tuberculosis infection in Bacille Calmette-Guerin vaccinated children. Diagnostic Microbiology & Infectious Disease 62: 389-94.

Cobanoglu N, Ozcelik U, Kalyoncu U et al. (2007) Interferon-gamma assays for the diagnosis of tuberculosis infection before using tumour necrosis factor-alpha blockers. International Journal of Tuberculosis & Lung Disease 11: 1177-82.

Connell TG, Curtis N, Ranganathan SC et al. (2006) Performance of a whole blood interferon gamma assay for detecting latent infection with Mycobacterium tuberculosis in children.[see comment]. Thorax 61: 616-20.

Cummings KJ, Smith TS, Shogren ES et al. (2009) Prospective comparison of tuberculin skin test and QuantiFERON-TB Gold In-Tube assay for the detection of latent tuberculosis infection among healthcare workers in a low-incidence setting. Infection Control & Hospital Epidemiology 30: 1123-6.

Diel R, Loddenkemper R, Meywald-Walter K et al. (2009) Comparative performance of tuberculin skin test, QuantiFERON-TB-Gold In Tube assay, and T-Spot.TB test in contact investigations for tuberculosis. Chest 135: 1010-8.

Diel R, Loddenkemper R, Meywald-Walter K et al. (2008) Predictive value of a whole blood IFN-gamma assay for the development of active tuberculosis disease after recent infection with Mycobacterium tuberculosis.[see comment]. American Journal of Respiratory & Critical Care Medicine 177: 1164-70.

Girardi E, Angeletti C, Puro V et al. Estimating diagnostic accuracy of tests for latent tuberculosis infection without a gold standard among healthcare workers.[see comment]. Euro Surveillance: Bulletin Europeen sur les Maladies Transmissibles = European Communicable Disease Bulletin 14: 2009.

Hansted E, Andriuskeviciene A, Sakalauskas R et al. (2009) T-cell-based diagnosis of tuberculosis infection in children in Lithuania: a country of high incidence despite a high coverage with bacille Calmette-Guerin vaccination. BMC Pulmonary Medicine 9: 41.

Harada N, Nakajima Y, Higuchi K et al. (2006) Screening for tuberculosis infection using whole-blood interferon-gamma and Mantoux testing among Japanese healthcare workers. Infection Control & Hospital Epidemiology 27: 442-8.

Hesseling AC, Mandalakas AM, Kirchner HL et al. (2009) Highly discordant T cell responses in individuals with recent exposure to household tuberculosis. Thorax 64: 840-6.

Higuchi K, Harada N, Mori T et al. (2007) Use of QuantiFERON-TB Gold to investigate tuberculosis contacts in a high school. Respirology 12: 88-92.

Higuchi K, Kondo S, Wada M et al. (2009) Contact investigation in a primary school using a whole blood interferon-gamma assay. Journal of Infection 58: 352-7.

Hotta K, Ogura T, Nishii K et al. (2007) Whole blood interferon-gamma assay for baseline tuberculosis screening among Japanese healthcare students. PLoS ONE 2

Janssens JP, Roux-Lombard P, Perneger T et al. (2008) Contribution of a IFN-gamma assay in contact tracing for tuberculosis in a low-incidence, high immigration area. Swiss Medical Weekly 138: 585-93.

Jones S, de GD, Wallach FR et al. (2007) Utility of QuantiFERON-TB Gold in-tube testing for latent TB infection in HIV-infected individuals. International Journal of Tuberculosis & Lung Disease 11: 1190-5.

Kang YA, Lee HW, Yoon HI et al. (2005) Discrepancy between the tuberculin skin test and the whole-blood interferon gamma assay for the diagnosis of latent tuberculosis infection in an intermediate tuberculosis-burden country.[see comment]. JAMA 293: 2756-61.

Kik SV, Franken WP, Arend SM et al. (2009) Interferon-gamma release assays in immigrant contacts and effect of remote exposure to Mycobacterium tuberculosis. International Journal of Tuberculosis & Lung Disease 13: 820-8.

Lighter J, Rigaud M, Eduardo R et al. (2009) Latent tuberculosis diagnosis in children by using the QuantiFERON-TB Gold In-Tube test. Pediatrics 123: 30-7.

Luetkemeyer AF, Charlebois ED, Flores LL et al. (2007) Comparison of an interferon-gamma release assay with tuberculin skin testing in HIV-infected individuals. American Journal of Respiratory & Critical Care Medicine 175: 737-42.

Mandalakas AM, Hesseling AC, Chegou NN et al. (2008) High level of discordant IGRA results in HIV-infected adults and children. International Journal of Tuberculosis & Lung Disease 12: 417-23.

Manuel O, Humar A, Preiksaitis J et al. (2007) Comparison of quantiferon-TB gold with tuberculin skin test for detecting latent tuberculosis infection prior to liver transplantation. American Journal of Transplantation 7: 2797-801.

Matulis G, Juni P, Villiger PM et al. (2008) Detection of latent tuberculosis in immunosuppressed patients with autoimmune diseases: performance of a Mycobacterium tuberculosis antigen-specific interferon gamma assay. Annals of the Rheumatic Diseases 67: 84-90.

Mirtskhulava V, Kempker R, Shields KL et al. (2008) Prevalence and risk factors for latent tuberculosis infection among health care workers in Georgia. International Journal of Tuberculosis & Lung Disease 12: 513-9.

National Institute for Health and Clinical Excellence (2005) Guideline development methods: information for national collaborating centres and guideline developers

O'Neal S, Hedberg K, Markum A et al. (2009) Discordant tuberculin skin and interferon-gamma tests during contact investigations: a dilemma for tuberculosis controllers. International Journal of Tuberculosis & Lung Disease 13: 662-4.

Okada K, Mao TE, Mori T et al. (2008) Performance of an interferon-gamma release assay for diagnosing latent tuberculosis infection in children. Epidemiology & Infection 136: 1179-87.

Pai M, Gokhale K, Joshi R et al. (2005) Mycobacterium tuberculosis infection in health care workers in rural India: comparison of a whole-blood interferon gamma assay with tuberculin skin testing.[see comment]. JAMA 293: 2746-55.

Piana F, Codecasa LR, Cavallerio P et al. (2006) Use of a T-cell-based test for detection of tuberculosis infection among immunocompromised patients. European Respiratory Journal 28: 31-4.

Ponce de LD, Acevedo-Vasquez E, Alvizuri S et al. (2008) Comparison of an interferon-gamma assay with tuberculin skin testing for detection of tuberculosis (TB) infection in patients with rheumatoid arthritis in a TB-endemic population. Journal of Rheumatology 35: 776-81.

Porsa E, Cheng L, Graviss EA (2007) Comparison of an ESAT-6/CFP-10 peptide-based enzyme-linked immunospot assay to a tuberculin skin test for screening of a population at moderate risk of contracting tuberculosis. Clinical & Vaccine Immunology: CVI 14: 714-9.

Porsa E, Cheng L, Seale MM et al. (2006) Comparison of a new ESAT-6/CFP-10 peptide-based gamma interferon assay and a tuberculin skin test for tuberculosis screening in a moderate-risk population. Clinical & Vaccine Immunology: CVI 13: 53-8.

Richeldi L, Losi M, D'Amico R et al. (2009) Performance of tests for latent tuberculosis in different groups of immunocompromised patients. Chest 136: 198-204.

Schoepfer AM, Flogerzi B, Fallegger S et al. (2008) Comparison of interferon-gamma release assay versus tuberculin skin test for tuberculosis screening in inflammatory bowel disease. American Journal of Gastroenterology 103: 2799-806.

Shovman O, Anouk M, Vinnitsky N et al. (2009) QuantiFERON-TB Gold in the identification of latent tuberculosis infection in rheumatoid arthritis: a pilot study. International Journal of Tuberculosis & Lung Disease 13: 1427-32.

Soborg B, Ruhwald M, Hetland ML et al. (2009) Comparison of screening procedures for Mycobacterium tuberculosis infection among patients with inflammatory diseases. Journal of Rheumatology 36: 1876-84.

Talati NJ, Seybold U, Humphrey B et al. (2009) Poor concordance between interferon-gamma release assays and tuberculin skin tests in diagnosis of latent tuberculosis infection among HIV-infected individuals. BMC Infectious Diseases 9: 15.

Topic RZ, Dodig S, Zoricic-Letoja I (2009) Interferon-gamma and immunoglobulins in latent tuberculosis infection. Archives of Medical Research 40: 103-8.

Tripodi D, Brunet-Court, Nael V et al. (2009) Evaluation of the tuberculin skin test and the interferon-gamma release assay for TB screening in French healthcare workers. Journal of Occupational Medicine & Toxicology 4: 30.

Vassilopoulos D, Stamoulis N, Hadziyannis E et al. (2008) Usefulness of enzyme-linked immunospot assay (Elispot) compared to tuberculin skin testing for latent tuberculosis screening in rheumatic patients scheduled for anti-tumor necrosis factor treatment.[see comment]. Journal of Rheumatology 35: 1271-6.

Vinton P, Mihrshahi S, Johnson P et al. (2009) Comparison of QuantiFERON-TB Gold In-Tube Test and tuberculin skin test for identification of latent Mycobacterium tuberculosis infection in healthcare staff and association between positive test results and known risk factors for infection. Infection Control & Hospital Epidemiology 30: 215-21.

Winje BA, Oftung F, Korsvold GE et al. (2008) Screening for tuberculosis infection among newly arrived asylum seekers: comparison of QuantiFERONTB Gold with tuberculin skin test. BMC Infectious Diseases 8: 65.

Zellweger JP, Zellweger A, Ansermet S et al. (2005) Contact tracing using a new T-cell-based test: better correlation with tuberculosis exposure than the tuberculin skin test. International Journal of Tuberculosis & Lung Disease 9: 1242-7.

Zhao X, Mazlagic D, Flynn EA et al. (2009) Is the QuantiFERON-TB blood assay a good replacement for the tuberculin skin test in tuberculosis screening? a pilot study at Berkshire Medical Center. American Journal of Clinical Pathology 132: 678-86.

STATUS IN NHSSCOTLAND

BEST PRACTICE GUIDANCE

Health Building Note 02-01

Cancer treatment facilities

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Health Building Note 02-01:
Cancer treatment facilities

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Health Building Note 02-01
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Front cover: Treatment area, Wigan Renal Unit

Preface

About Health Building Notes

Health Building Notes give "best practice" guidance on the design and planning of new healthcare buildings and on the adaptation/extension of existing facilities.

They provide information to support the briefing and design processes for individual projects in the NHS building programme.

The Health Building Note suite

Healthcare delivery is constantly changing, and so too are the boundaries between primary, secondary and tertiary care. The focus now is on delivering healthcare closer to people's homes.

The Health Building Note framework (shown below) is based on the patient's experience across the spectrum of care from home to healthcare setting and back, using the national service frameworks (NSFs) as a model.

Health Building Note structure

The Health Building Notes have been organised into a suite of 17 core subjects.

Care-group-based Health Building Notes provide information about a specific care group or pathway but cross-refer to Health Building Notes on **generic (clinical) activities** or **support systems** as appropriate.

Core subjects are subdivided into specific topics and classified by a two-digit suffix (-01, -02 etc), and may be further subdivided into Supplements A, B etc.

All Health Building Notes are supported by the overarching Health Building Note 00 in which the key areas of design and building are dealt with.

Example

The Health Building Note on accommodation for adult in-patients is represented as follows:

> "Health Building Note 04-01: Adult in-patient facilities"

The supplement to Health Building Note 04-01 on isolation facilities is represented as follows:

> "Health Building Note 04-01: Supplement 1 – Isolation facilities for infectious patients in acute settings"

Health Building Note number and series title	Type of Health Building Note
Health Building Note 00 – Core elements	Support-system-based
Health Building Note 01 – Cardiac care	Care-group-based
Health Building Note 02 – Cancer care	Care-group-based
Health Building Note 03 – Mental health	Care-group-based
Health Building Note 04 – In-patient care	Generic-activity-based
Health Building Note 05 – Older people	Care-group-based
Health Building Note 06 – Diagnostics	Generic-activity-based
Health Building Note 07 – Renal care	Care-group-based
Health Building Note 08 – Long-term conditions/long-stay care	Care-group-based
Health Building Note 09 – Children, young people and maternity services	Care-group-based
Health Building Note 10 – Surgery	Generic-activity-based
Health Building Note 11 – Community care	Generic-activity-based
Health Building Note 12 – Out-patient care	Generic-activity-based
Health Building Note 13 – Decontamination	Support-system-based
Health Building Note 14 – Medicines management	Support-system-based
Health Building Note 15 – Emergency care	Care-group-based
Health Building Note 16 – Pathology	Support-system-based

Other resources in the DH Estates and Facilities knowledge series

Health Technical Memoranda

Health Technical Memoranda give comprehensive advice and guidance on the design, installation and operation of specialised building and engineering technology used in the delivery of healthcare (for example medical gas pipeline systems, and ventilation systems).

They are applicable to new and existing sites, and are for use at various stages during the inception, design, construction, refurbishment and maintenance of a building.

All Health Building Notes should be read in conjunction with the relevant parts of the Health Technical Memorandum series.

Activity DataBase (ADB)

The Activity DataBase (ADB) data and software assists project teams with the briefing and design of the healthcare environment. Data is based on guidance given in the Health Building Notes, Health Technical Memoranda and Health Technical Memorandum Building Component series.

1. Room data sheets provide an activity-based approach to building design and include data on personnel, planning relationships, environmental considerations, design character, space requirements and graphical layouts.
2. Schedules of equipment/components are included for each room, which may be grouped into ergonomically arranged assemblies.
3. Schedules of equipment can also be obtained at department and project level.
4. Fully loaded drawings may be produced from the database.
5. Reference data is supplied with ADB that may be adapted and modified to suit the users' project-specific needs.

Note

The sequence of numbering within each subject area does not necessarily indicate the order in which the Health Building Notes were or will be published/printed. However, the overall structure/number format will be maintained as described.

Executive summary

This Health Building Note covers the policy and service context, and planning and design considerations, for cancer treatment facilities.

It covers specific planning and design considerations for chemotherapy and radiotherapy units. It describes spaces that are unique to those units. It also describes any variations to common hospital spaces and clarifies requirements for these spaces, where necessary.

For a full list of space components, see the example schedules of accommodation for a chemotherapy unit serving a population of 400,000 and for a two and four-linear accelerator radiotherapy unit. Links to guidance on common spaces are provided from the example schedules.

Key changes since Health Building Note 54 (2006)

The major differences in 'Cancer treatment facilities' compared with Health Building Note (HBN) 54 (2006) are:

1 A dedicated cancer out-patients department is no longer included, as it is assumed that the same functions can take place within a general out¬patients department, within either a hospital or a primary care setting.

2 A suite of entrance facilities is not included, as it is assumed that patients attending the chemotherapy and radiotherapy units would use the hospital's main entrance facilities.

3 The guidance now includes the addition of radiotherapy medical physics and technology accommodation, with some specific core rooms, and some optional rooms depending on the proximity of the main medical physics department.

4 It also now includes an on-treatment review suite for both chemotherapy and radiotherapy (two separate areas). This provides clinicians with appropriate facilities for reviewing patients at the same time as they attend for their treatment.

5 It is assumed that radiotherapy units will be accommodating radiotherapy equipment with an output of no more than 15 MV, as this was felt by the expert group to be the likely maximum requirement. Units operating equipment at higher output levels than this are advised to seek specific advice on radiation protection requirements.

6 The guidance includes the superficial/orthovoltage radiotherapy treatment room only as optional provision.

7 It includes a facility associated with both imaging and treatment rooms for radiotherapists to undertake data preparation, calculations and image review in a separate area to the control areas – to provide a quiet, uninterrupted environment for this work to take place.

8 It assumes that staff will make use of shared central changing facilities and no longer includes local provision for staff changing (although this has been included as an optional facility).

Contents

1 Policy context

Background

1.1 The NHS Cancer Plan (DH, 2000), which set out the first-ever comprehensive strategy to tackle cancer, was updated in 2007 with the publication of the Cancer Reform Strategy.

1.2 More recently the Department of Health published 'Improving outcomes: a strategy for cancer' (January 2011), setting an aspirational challenge for the National Cancer Programme. In the context of the Government's reforms of the health service and changes to the provider, commissioning and public health agendas, the programme aims to save at least an additional 5000 lives in England each year by 2015, in order to equal the European average.

1.3 This assumes a level of awareness, presentation and early diagnosis that matches levels in the rest of Europe. However, earlier diagnosis is just the beginning of the picture. Our clinical facilities, treatment delivery and technology must also be capable of matching these aspirations.

1.4 Current reference documents for cancer services include those linked to in the sections below.

Note

Policy is continually reviewed and updated. Readers are encouraged to ensure they are accessing the latest version of any documents referenced.

Quality of environment

1.5 Project teams should seek the views of all users from the onset of the planning and design process.

1.6 Whatever the setting or basis of treatment delivery, the privacy, dignity and comfort of patients are key.

1.7 Important features of the environment include: external views and access to gardens where possible; positive distractions, for example with interesting artwork; the ability to control temperature locally (some patients are very sensitive to temperature), especially in the treatment suites; control over noise and lighting; and control over privacy.

1.8 Project teams may wish to review the research literature available regarding colour schemes in chemotherapy facilities.

1.9 Macmillan Cancer Support is working hard to improve cancer care environments. It has developed the Macmillan Quality Environment Mark (MQEM), a national evidence-based benchmark for the patient experience in cancer facilities. All cancer services are recommended to adopt MQEM, either as part of their service improvement process or in the course of developing new facilities. See also: Macmillan Cancer Environments.

Delivering same-sex accommodation

1.10 See 'Delivering same-sex accommodation' under 'Functional design issues' in Health Building Note 00-01. Guidance applying to generic recurring accommodation such as in-patient accommodation is included in the relevant topic.

1.11 Sometimes, patients who have frequent, short admissions – like patients undergoing chemotherapy – may prefer to be cared for with others with the same condition, irrespective of their gender. This is acceptable, as long as it is the decision of the whole group and does not adversely affect the care of others. It is not acceptable where the only justification is frequent admission, and there is no recognisable group identity. Nor is it acceptable where the main justification is organisational convenience. Further guidance is provided at paragraph 9.22, 'Chemotherapy treatment suite'. See also 'Eliminating Mixed Sex Accommodation (PL/CNO/2010/3)'.

2 Diagnosis

2.1 Following an out-patient consultation, the patient will undergo investigations (usually imaging and pathology). They will then return to an out-patient setting for the results and to discuss possible treatment plans. Oncology out-patient facilities are assumed to form part of the general out-patients department, with generic rooms used on a sessional basis.

2.2 Diagnostic imaging/pathology services will usually be provided from a central facility.

2.3 Spaces will be required for multidisciplinary team meetings, which are an integral part of the pathway prior to patients returning for results. These meetings can take place within generic seminar/meeting rooms provided that there are suitable facilities for teleconferencing, accessing patient records and viewing PACS images and pathology slides, where necessary.

2.4 See Health Building Note 6 Vol 1, 'Facilities for diagnostic imaging and interventional radiology'; Health Building Note 15, 'Facilities for pathology services'.

3 Overview of treatment

3.1 An overall treatment strategy may involve surgery, chemotherapy and/or radiotherapy, alongside hormone therapy and tumour-suppressive drugs. Some patients may receive chemotherapy and radiotherapy concurrently. Where chemotherapy and radiotherapy facilities are provided from the same location, they should be co-located, for the patient's convenience and to enable efficient working practices. The working pattern of clinical oncologists means that they need to access both areas and their administration bases.

3.2 Chemotherapy and radiotherapy facilities are largely self-contained, and they require good access to the main diagnostic, surgical, in-patient, critical care, accident and emergency (A&E), and rehabilitation facilities, along with the main medical physics, pharmacy and pathology facilities.

3.3 Patient support services such as wig fitting and prostheses services, information services, and complementary therapies are essential. They may be provided from the general out-patient departments, ideally located close by; if not, provision should be made within the oncology unit itself.

4 Chemotherapy

4.1 Chemotherapy is the use of systemic anti-cancer (or cytotoxic) drugs that destroy cancer cells. The types of chemotherapy used will depend on a number of factors including where the cancer started (primary) and/or whether it has spread (secondary or metastatic).

4.2 It is being used increasingly widely, including in a wider range of solid cancers than previously, with new drugs being developed.

4.3 Patient-specific treatment protocols/regimens will be prescribed, and drugs may be given over a period of one or two weeks, or two or more drugs may be administered over a period of one day. A typical regimen may last over six months, with the patient returning at frequent intervals for treatment.

4.4 The drugs are usually given by the intravenous route, either as a bolus over minutes (on an out-patient basis) or as an infusion over hours (as a day case), but may be taken orally as a tablet or capsule. Some patients will be admitted for elective chemotherapy owing to the administration times/length of the regimen. These patients would receive their chemotherapy on the ward, whether bolus or infusion.

4.5 The patient will undergo regular imaging investigations and pathology tests to monitor the success of the treatment.

4.6 Post-chemotherapy supportive therapies may include the prescribing of anti-emetic drugs, which will require collection from a pharmacy facility located close by.

Intrathecal chemotherapy

4.7 Compliance with HSC 2008/001 'Updated national guidance on the safe administration of intrathecal chemotherapy' requires that new or updated chemotherapy facilities include a "permanently designated area for intrathecal chemotherapy for trusts wishing to provide this service". It is recommended that this should take the form of a dedicated treatment room or rooms.

4.8 It is not desirable to store intrathecal chemotherapy drugs outside the pharmacy between issuing and administration, and emergency stocks should never be held on the ward. However, if the drugs have to be issued and there will be a short delay before administration, they should be stored in a dedicated container/refrigerator reserved for this purpose alone.

4.9 More detailed information is provided within Health Service Circular 2008/001 'Updated national guidance on the safe administration of intrathecal chemotherapy'.

4.10 See also Chapter 9, 'Chemotherapy unit'.

5 Radiotherapy

5.1 Radiotherapy is the use of ionising radiation to damage and kill diseased cells. Its main use is found in cancer treatment where it can be used on its own, with curative or palliative intent, or as part of a wider treatment of the cancer, which might also involve surgery or chemotherapy.

5.2 Radiation exposure can damage cell DNA and this can lead to the cell being unable to reproduce, or to cell death. Healthy cells are generally more able to repair this kind of damage than cancerous cells and, by splitting radiotherapy treatments into treatment fractions, it is possible to take advantage of this repair mechanism and inflict damage on the cancer while reducing the effect on healthy tissues. The precise fractionation of the radiotherapy is therefore a crucial part of the prescription.

5.3 Individual patient treatment plans are produced to enable the delivery of prescribed radiation doses to the disease. The planning process involves some form of imaging (usually a CT scan) and the outlining of various structures, such as the tumour and other organs, within the images. Certain organs, generally close to the tumour, are designated "organs at risk" (OARs) and need to receive low radiation doses to avoid long-term, undesirable side-effects. Radiotherapy treatments are always, then, a careful balance of clinical risk between the probability of controlling the tumour and the probability of causing harm to normal tissues.

5.4 Once a plan has been produced, approved and verified using further imaging, the patient can receive treatment.

Radiotherapy staff groups

5.5 Doctors, physicists, dosimetrists, radiographers and technologists are all required to work together to provide high-quality radiotherapy treatment.

5.6 **Clinical oncologists** … take overall responsibility for the patient's treatment. They are involved in diagnosing and determining the staging of the cancer, deciding on a course of treatment and prescribing the radiation dose. The process of prescribing is complicated and involves the definition of the target volume as well as determining the radiation dose to be delivered.

5.7 **Physicists** … develop and oversee the scientific infrastructure of the oncology centre. They are responsible for ensuring the proper commissioning and calibration of radiation-producing equipment and the safe use of radiation, protecting the patients, staff and members of the public in compliance with the relevant legislation.

5.8 **Dosimetrists** … plan radiotherapy treatments based on the requirements of the oncologist. They require good knowledge of human anatomy and equipment capabilities to produce practical, successful treatment plans. Dosimetrists also check radiotherapy plans and help with the development of new types of treatment.

5.9 **Radiographers** … take the patient through the treatment process. Radiographers are involved in scanning the patient before the treatment plans are created and in producing an accurate daily patient set-up on the day of treatment. They operate the therapy equipment to deliver the radiation dose and have an important role in providing advice and counselling for the patient and their family.

5.10 **Clinical technologists** … provide on-site technical expertise for radiotherapy equipment. Technicians carry out repair work on the machines as well as doing routine maintenance to prevent breakdowns. They also carry out aspects of equipment quality assurance.

5.11 **Nursing staff** … provide support to patients and on-treatment reviews, where they may assess patients and prescribe supportive drugs to reduce treatment toxicities.

5.12 See also Chapter 10, 'Radiotherapy unit'.

Teletherapy

5.13 This is the most frequently used form of radiotherapy. A radiation beam is generated by a machine source of radiation external to the patient and at a distance from the body. The two most important characteristics of treatment are:

a. the localisation of the beam to the target volume; and

b. the level of dose deposited in the tumour. In the planning process, radiation beams/sources are simulated in order to calculate and assess the optimum treatment geometry and dose delivery by the radiation.

5.14 Patients usually attend the radiotherapy unit on an out-/day-patient basis, or they may attend as an in-patient coming from the ward to receive their treatment. Teletherapy is delivered by large machines (usually linear accelerators) situated within shielded facilities with very particular requirements, as described below.

Linear accelerators (linacs)

5.15 The linear accelerator is the primary and mostly widely used treatment unit for radiotherapy (teletherapy). Radiation beams are produced by accelerating electrons to very high energies and, depending on the type of radiation beam required, directing the accelerated electrons onto a metal target.

5.16 The radiation beams are shaped by collimators[1] or applicators in the linac head in order to direct precisely defined radiation fields into the target volume within the patient. The linac measures the radiation output in order to deliver precisely determined radiation doses.

5.17 This guidance assumes the provision of linacs operating at up to 15 MV; units deciding to operate linacs above this output should obtain specialist advice, as additional radiation protection considerations will be required.

Image-guided radiotherapy (IGRT)

5.18 Image-guided radiotherapy achieves localisation of the beam to within the target volume by imaging the patient once they are on the treatment couch in the treatment position. This means that if the tumour has moved since the previous treatment, the patient can be repositioned so that the radiation targeting is improved.

5.19 IGRT can potentially be implemented in a number of ways. The most commonly used method is to perform "cone-beam CT" scans by use of an X-ray tube and detector mounted onto the linac gantry. A comparison is made between the CT scan from the treatment planning process and the scan made with the patient on the treatment couch at treatment delivery. A decision can then be made about whether the patient position should be adjusted.

Intensity-modulated radiotherapy (IMRT)

5.20 Conventional radiotherapy is often limited in terms of its ability to avoid certain organs and to deposit the dose within the confined tumour region. Intensity-modulated radiotherapy is a way of improving these abilities by creating radiation fields with varying intensities. Different methods are used by linac manufacturers to achieve these intensity-modulated fields, such as "step-and-shoot", where individual "beamlets" are created by the MLC in sequence, or "sliding window", where the MLC moves across the field throughout treatment to vary the beam intensity.

5.21 While the technical performance of modern linear accelerators is such that IMRT is achievable, the challenge often lies in producing the treatment plans. Instead of manually changing dose contributions from each beam, new planning software can "optimise" beam arrangements and dose contributions to give the best possible dose distributions ("inverse planning"). A balance is often required between the dose delivered to critical organs and that delivered to the target volume. IGRT is an essential part of IMRT as sharper dose gradients are used, requiring more accurate positioning.

Rotational IMRT

5.22 IMRT can be performed either with the linac gantry at fixed angles or by treating while the gantry is rotated around the patient. Often, two or more rotations of the gantry are required to give the desired dose distributions. Rotational IMRT can often be delivered with lower total monitor units than conventional IMRT and tends to deliver lower doses to volumes outside the target organ.

5.23 Tomotherapy is another rotational IMRT solution; unlike conventional linacs, it is designed to perform

[1] Modern linacs are fitted with multi-leaf collimators (MLCs), which are able to define customisable field shapes, usually to within tenths of a millimetre.

only rotational IMRT. Tomotherapy does not use MLCs but has a series of shutters which can open and close very quickly. As the radiation beam is rotated around the patient, these shutters are used to shield parts of the patient, so creating dose distributions which can be designed to conform tightly to the treatment regions.

Stereotactic radiotherapy/radiosurgery

5.24 Stereotactic radiosurgery (a single fraction treatment) and radiotherapy (more than one fraction) deliver an ablative (or destructive) dose of radiation to a small target volume. The doses delivered per fraction are significantly larger than a conventional radiotherapy treatment, but the total biologically effective dose over the course of treatment is generally the same. The aim is different from conventional radiotherapy and IMRT in that the radiation dose per fraction is sufficient to destroy, rather than to damage, tumour cells. Suitable tumour targets tend to be very small, and many beams are used to maximise the dose delivered to the tumour while minimising high-dose delivery to healthy tissues.

5.25 The high doses per fraction mean that geometric precision is extremely important. IGRT therefore plays a very important role in radiosurgery in making sure that the tumour is properly targeted. In regions where the target might be moving (that is, in the lungs, abdomen etc), techniques such as gating or chest compression are often employed to achieve superior targeting.

5.26 There are many stereotactic delivery systems available, including conventional linear accelerators. While linacs can be used to perform radiosurgery, other pieces of equipment are increasingly being specifically designed for this purpose. Robotic radiosurgery can be performed with a linear accelerator attached to a robotic arm. The patient is positioned either sitting or lying down while the arm moves around, exposing the patient to many small beamlets (hundreds per treatment). It makes use of a number of imaging techniques to locate the tumour throughout treatment, including respiratory and bone anatomy tracking.

Brachytherapy

5.27 This is internally delivered radiotherapy where a radioactive source is positioned in the patient's body, inside or next to the tumour, either permanently or temporarily. This can be advantageous in some clinical cases as the radiation dose is more restricted to a short distance from the source and can reduce the irradiation of normal tissue. Patients attend as day case patients or are admitted as in-patients, depending on the type of treatment approach.

5.28 Brachytherapy is performed either by the insertion of radioactive wires and seeds directly into the tumour or, more commonly, by driving a single highly radioactive pellet down a transfer tube placed inside or next to the tumour. It is routinely used for gynaecological, prostate, breast and skin cancers. As an example of a modern development in breast brachytherapy, a small balloon and catheter can be inserted, intra-operatively, into the tumour excision site. A radioactive source is then driven into the centre of the balloon to treat the surrounding tissues.

Temporary implants

5.29 Before temporary radioactive sources are placed in a patient's body, applicators or catheters have to be inserted into the patient, usually in a standard operating theatre. The patient is then taken on a trolley from the operating theatre to an imaging suite, where the applicator's/catheter's precise position and geometry is determined with respect to the patient's anatomy.

5.30 The patient is then transferred to the brachytherapy suite, which contains a shielded source container built into an after-loading machine. Within the shielded source container is a single, highly radioactive source, usually iridium-192. The applicators/catheters within the patient are connected to the after-loading machine via transfer tubes. Using a computer control unit, the radioactive source is then mechanically transferred to the applicators to deliver the treatment. At the end of the treatment, the applicators/catheters are removed from the patient.

5.31 Certain insertions may be undertaken in the brachytherapy suite, provided that it is suitably equipped for surgical procedures, including anaesthesia, and has suitable imaging facilities.

High dose rate (HDR) brachytherapy

5.32 A single, highly active source of iridium-192 is transferred mechanically from the source container to the first applicator tube and stepped along the treatment length. It is then retracted and placed

into the next applicator. The dose required is delivered in a single treatment lasting typically 10 to 20 minutes.

Pulsed dose rate (PDR) brachytherapy

5.33 This is similar to high dose rate brachytherapy but the source is only a tenth of the activity of a high dose rate source, and instead of a single treatment lasting 10 to 20 minutes, several treatments are delivered, each lasting about 10 minutes and repeated at regular intervals for up to 48 hours. The patient remains within the brachytherapy suite, provided as a specialist facility within the in-patient accommodation, and requires nursing facilities.

Permanent implants

5.34 Small radioactive sources are inserted or implanted directly into the tissue in a standard operating theatre, although specialist equipment is required during the procedure. Due to the low activity and low energy of the radiation used in these implants, the patient can be nursed for the duration of their stay in an ordinary single room where they are monitored for potentially expelled sources.

Unsealed radioactive sources

5.35 The source is usually administered to the patient in the form of a liquid (taken as a drink), capsule or by intravenous injection.

5.36 Where the source is injected, aseptic and sterile conditions are required. Some therapeutic radiopharmaceuticals arrive from the manufacturer ready to use, while others must be prepared in the hospital radiopharmacy (due to limited stability after preparation). Where radiopharmaceuticals are prepared on-site, they should be delivered on a shielded trolley.

5.37 The patient will be accommodated in a specialist shielded single room associated with the in-patient accommodation, and will remain there until the radiation level drops below a defined threshold.

5.38 See also paragraph 10.116, ‘HDR brachytherapy suite (optional)’ and paragraph 11.7, ‘Specialist in-patient accommodation’.

6 Surgical oncology

6.1 Most curative patients will have some form of surgery at some point in their treatment. Surgical oncology is undertaken in standard operating theatres, which will usually form part of the main operating theatre suite. Guidance on the design of surgical facilities for in-patients is provided in Health Building Note 26 Volume 1 – 'Facilities for surgical procedures'. (Health Building Note 10-02 provides guidance on facilities for day case surgery.)

7 Emergency care

7.1 Non-surgical oncology patients do sometimes suffer acute complications from their cancer and its treatment, and may require emergency care. Local cancer networks should have clear policies and pathways on the management of complications. All hospitals which might receive these patients should develop an "acute oncology" service to respond effectively, or otherwise have "treat and transfer" arrangements in place.

7.2 If a dedicated urgent assessment facility is provided, it is usually part of the oncology in-patient accommodation. Where this facility is not available, patients will be seen in the main Accident and Emergency department. If a patient becomes unwell on the oncology unit itself, clinical spaces within the on-treatment suites in the chemotherapy/radiotherapy units will be used for their assessment. These patients may subsequently be admitted to the main ward via a discreet route.

7.3 See also 'Chemotherapy services in England: Ensuring quality and safety' (DH, 2009); 'Manual for Cancer Services: acute oncology – including metatastic spinal cord compression measures' (DH, 2011).

8 In-patient care

8.1 Patients may be admitted electively for chemotherapy or brachytherapy treatment. Some patients who become acutely ill may also require admission.

8.2 Ward accommodation for cancer patients does not differ from ward accommodation for other patient groups. Depending on the scale of the facilities, designated oncology beds may be provided within the main surgical and medical wards, or there may be dedicated oncology wards, including wards/beds for haemato-oncology.

8.3 Dedicated beds for palliative care may also be provided, located in a quiet area of the ward.

8.4 See also Chapter 11, 'In-patient facilities'; King's Fund, 'Improving environments for care at end of life'.

Critical care facilities

8.5 Critical care areas (CCAs) for cancer patients do not differ from CCAs for other patient groups. Guidance on critical care facilities is provided in Health Building Note 04-02 – 'Facilities for critical care'.

9 Chemotherapy unit

9.1 This section describes a chemotherapy unit for the delivery of intravenous and intrathecal chemotherapy, including the management of patients.

9.2 It includes specific planning and design considerations and space information for an on-treatment suite and a chemotherapy treatment suite.

Planning and design considerations

9.3 See Chapter 1, 'Policy context' regarding quality of environment.

9.4 The equipping of generic clinical rooms may depend on the patient groups attending on a local basis; for example, tumour site-specific teams may have particular requirements.

9.5 It is assumed that a pneumatic tube system will be used for the transportation of blood samples, if these are being taken by staff on the unit.

Children's facilities

9.6 The provision of dedicated chemotherapy facilities for children and young people is recommended. However, where there is some shared use of facilities, the patient pathways should be kept separate as far as possible and, depending on local need, some clinic spaces should be designated for paediatric use, and decorated appropriately. (Paediatric patients should be treated in age-appropriate treatment facilities as per the NICE guidance.)

9.7 See 'Improving outcomes in children and young people with cancer' (NICE); 'Improving outcomes in children and young people with cancer' (DH).

Clinical trials

9.8 The following accommodation is assumed to be provided elsewhere as part of a trust-wide clinical trials service and is outwith the scope of this guidance:

1 consulting/examination room(s);

2 interview and counselling room(s);

3 dedicated in-patient accommodation, where drugs trials involve overnight stays.

Functional relationships

Internal functional relationships

9.9 Figure 1 outlines the relationship between the various functions within a chemotherapy unit.

Relationships with other departments

9.10 The chemotherapy unit should be located with good access to imaging facilities, and to a pharmacy dispensary and multi-disciplinary team facilities if these are not provided on the unit.

Pharmacy aseptic preparation

9.11 Injectable cytotoxic drugs for use in chemotherapy must be prepared in a dedicated pharmacy aseptic unit – this may be located within a central pharmacy facility or as a pharmacy outpost/"satellite" adjacent to the chemotherapy unit. This guidance assumes the former, and therefore the schedule of accommodation does not provide an allowance for these facilities.

Drugs storage and disposal facilities

9.12 Cytotoxic drugs are hazardous, and should be stored in locked and alarmed facilities. The discharge of cytotoxic materials into the environment is regulated. Accordingly, specific routes for disposal must be agreed and described in local rules and protocols. The means of delivery must be safe, secure and traceable. It is not appropriate to deliver cytotoxic drugs by pneumatic tube owing to the risks involved.

9.13 See Health Building Note 14-01 for further guidance on the design of an aseptic unit.

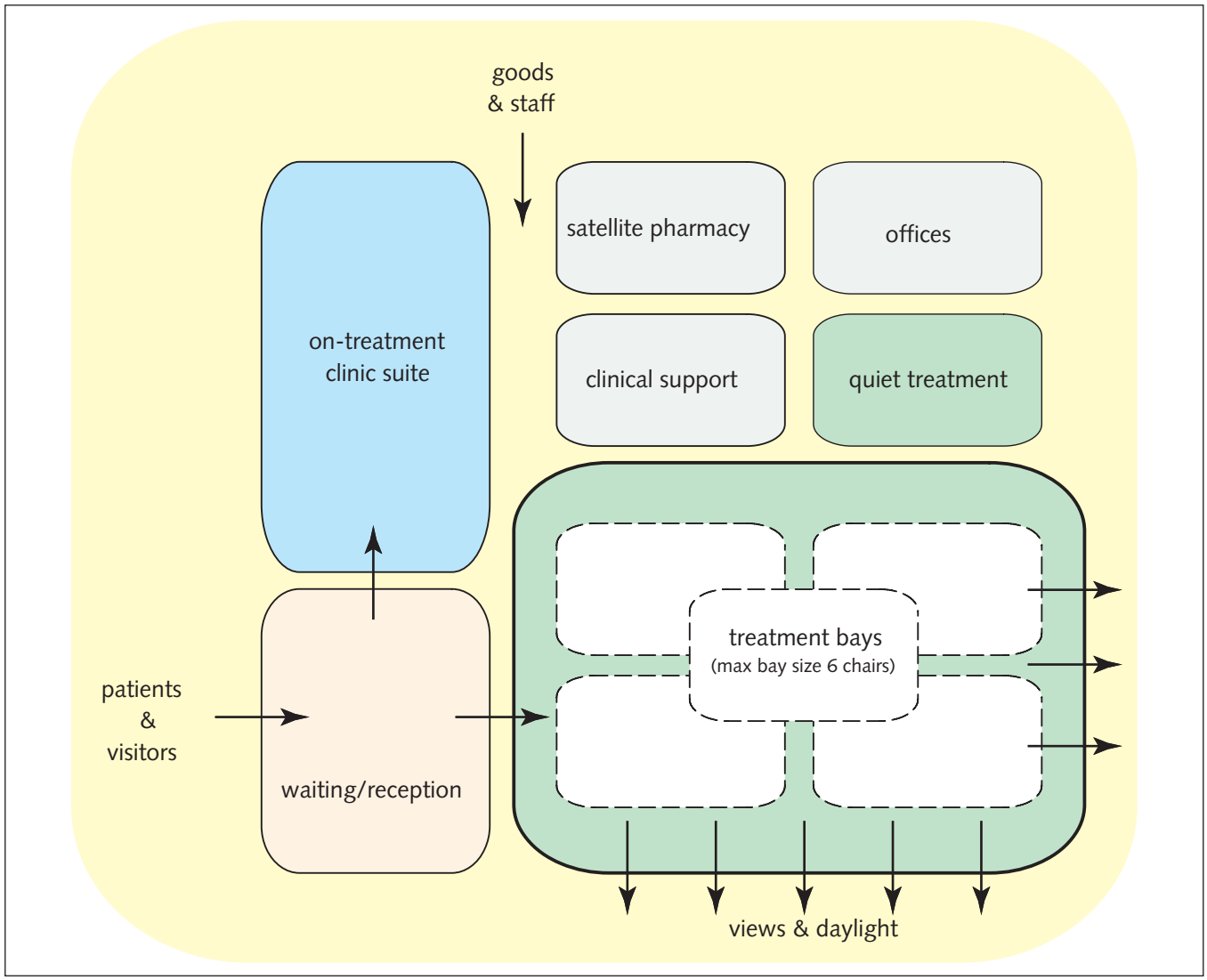


Figure 1 Chemotherapy unit: internal functional relationships

On-treatment suite

Function of the suite

9.14 The on-treatment suite may provide for the following functions:

- pre-treatment consultations;
- delivery of oral chemotherapy;
- phlebotomy; and
- the education, assessment and management of patients during the course of their chemotherapy treatment.

9.15 It comprises the following core clinical accommodation:

- examination/therapy rooms, for general nursing procedures;
- consulting/examination rooms;
- interview and counselling.

Note

If the unit is providing intrathecal treatments (not all providers do), one room must be designated for this purpose. This guidance assumes that one of the exam/therapy rooms in the on-treatment suite will be designated. Some trusts may opt to provide this room elsewhere.

9.16 This guidance assumes that phlebotomy takes place in these clinical rooms rather than in separate designated rooms.

9.17 This guidance also assumes that wig/prostheses fitting, complementary therapies, information

services and other patient support functions will be delivered from generic rooms in the general out-patients department. If the out-patients department is not close by, these services should be delivered from generic rooms in this suite.

Specific space considerations

9.18 If project teams opt to provide a waiting area that serves the entire unit, a separate waiting area would not be required within the on-treatment suite.

9.19 The interview room should be located to allow discrete egress without passing through the public areas.

9.20 Separate storage is required for intrathecal drugs, as directed by the updated national guidance on the safe administration of intrathecal chemotherapy.

9.21 See HSC 2008/001 'Updated national guidance on the safe administration of intrathecal chemotherapy'.

Chemotherapy treatment suite

9.22 The overall size of the treatment suite will depend on patient throughput. A mixture of open-plan and individual treatment spaces is recommended.

9.23 Patients requiring central venous catheters (CVCs) may need to visit the central diagnostic imaging facility. Some patients will have CVCs inserted in the individual treatment areas in the chemotherapy suite.

9.24 Cytotoxic drugs have a deleterious effect on the patient's immune system, and great emphasis should be placed on designs and finishes that enable staff to keep the treatment unit clean and as free from infection as is reasonably possible while providing a comfortable environment. The design of treatment areas should facilitate easy cleaning and decontamination.

Chemotherapy treatment area

9.25 Open-plan areas should be divided into smaller zones of no more than six chairs. This flexibility in design will enable teams to manage the area according to patients' preferences at any given time, including to create gender separation if required.

9.26 Patients may have adverse reactions to the treatment. Medical oxygen and medical vacuum outlets should be provided, which may be shared between two bays, plus an emergency box with good access to resuscitation facilities.

9.27 Patient entertainment facilities should be provided.

Open-plan chemotherapy treatment area divided into zones (courtesy University Hospital of North Staffordshire NHS Trust)

Patients undergoing chemotherapy (courtesy University Hospital of North Staffordshire NHS Trust)

Chemotherapy treatment: Single room

9.28 There should also be a "quiet" zone of single rooms with en-suite sanitary facilities; these could be used for patients who require clinical seclusion, who

wish to receive their treatment in private, or who require the use of scalp cooling devices.

Chemotherapy preparation room

9.29 Facilities are required for storing and preparing sterile packs, lotions and drugs for immediate use, and for preparing/storing trolleys. This provision may be provided as a central facility (16 m^2 would serve 24 patients) or as smaller devolved rooms (9 m^2 per six-chair bay). A local decision will be required as to whether to provide a computer workstation within this area.

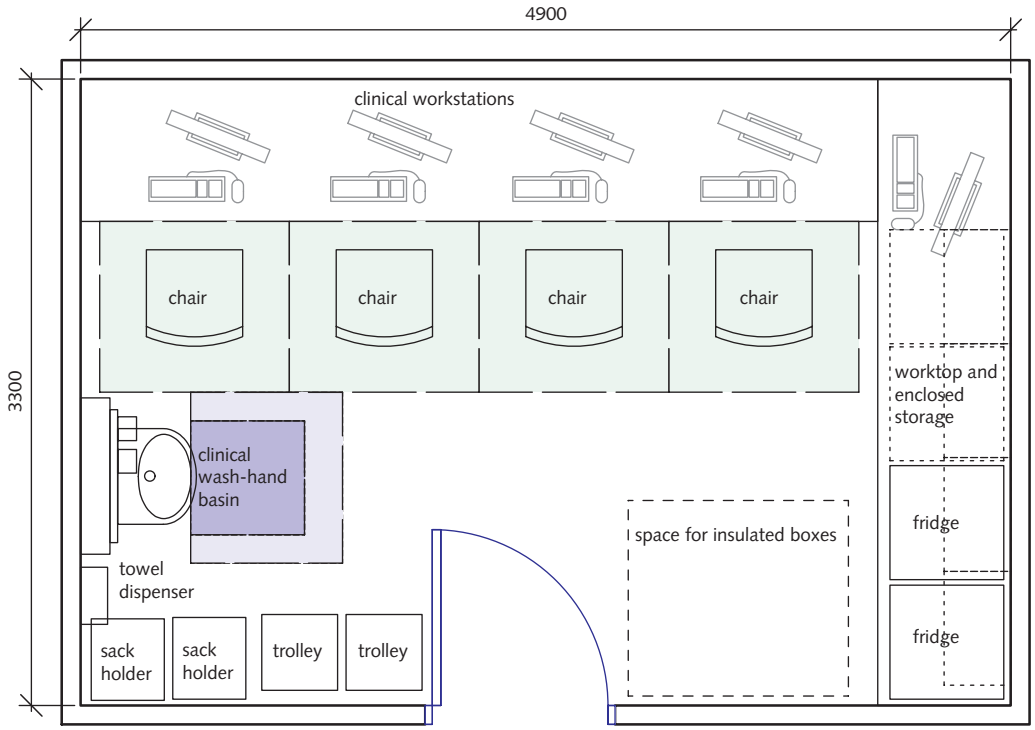


Figure 2 Chemotherapy prep room 16 m^2: example layout

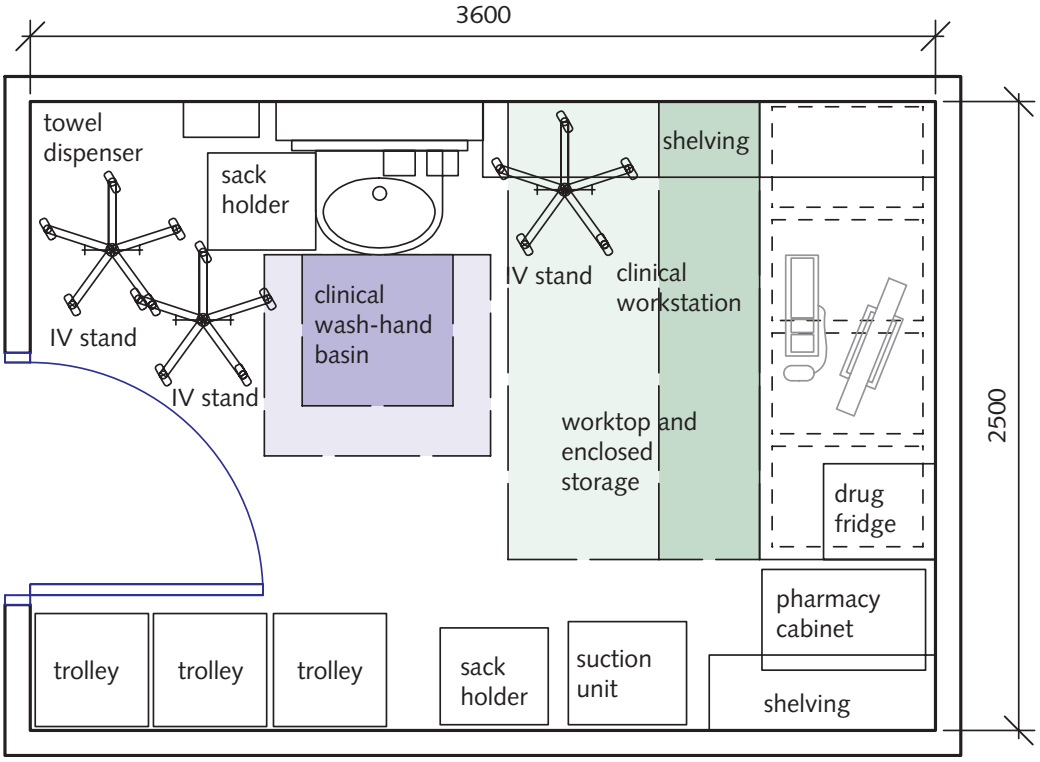


Figure 3 Chemotherapy prep room 9 m^2: example layout

10 Radiotherapy unit

10.1 This section describes the specific planning and design considerations and space information for a main radiotherapy unit that includes the following accommodation:

- On-treatment review suite
- Radiotherapy treatment suite; superficial/ orthovoltage radiotherapy treatment facilities may be provided in this suite
- Imaging suite
- Mould suite
- Radiotherapy physics and technology accommodation

10.2 An HDR brachytherapy suite may be provided and is also covered in this section.

10.3 A satellite radiotherapy unit may be provided with close links to the main unit, with two radiotherapy treatment rooms being the usual minimum viable provision. The actual requirements for a satellite unit will be determined by local policy. The schedule of accommodation includes an example for a satellite unit (two bunkers).

Planning and design considerations

Future flexibility

10.4 The planning and design of radiotherapy facilities should be flexible enough not only to respond to changes in the clinical service, but also to enable equipment servicing and replacement and to accommodate new emerging technologies. The design should ensure that access is sufficient to allow new equipment to be installed with minimal disruption to clinical services. Good external access is required for delivery of equipment by large vehicles.

10.5 Since the treatment room will outlast the linear accelerator, it is prudent to design the shielding to allow for the highest-energy machine and widest beam that are likely to be installed in the future. It is therefore recommended that all treatment rooms be designed to house at least 15 MV machines. The design should also allow for neutron protection to be added, if and when required.

10.6 Where a treatment room is being upgraded to take a higher-energy machine, walls can sometimes be upgraded. Care should be taken to prevent the generation of secondary radiation.

UK legislation

10.7 There are three major items of UK legislation that affect the design and operation of radiotherapy facilities:

1 the Radioactive Substances Act 1993;

2 the Ionising Radiations Regulations 1999 and the Health and Safety Commission's (HSC) approved code of practice 'Working with ionising radiation'; and

3 the Ionising Radiation (Medical Exposure) Regulations 2000.

Use of radiation

10.8 When planning and designing radiotherapy services, project teams must seek radiation protection advice early on from the local radiation protection advisor (RPA) and external advisors. A prior risk assessment is mandatory at the building design stage.

10.9 Every radiotherapy facility should employ one or more radiation protection supervisors (RPS). The RPS will be a good source of information on local practices and safety rules.

10.10 Under the Ionising Radiation (Medical Exposure) Regulations 2000, a medical physics expert (MPE) needs to be involved in all procedures involving radiotherapy. The MPE and RPA may be the same person, or they may be different. Both should be consulted when designing new facilities.

10.11 Early consultation with manufacturers of radiotherapy equipment is also necessary.

Security of radioactive materials

10.12 The planning and design team should also consult the local Counter Terrorism Security Adviser (CTSA) at the earliest opportunity for specialist advice in relation to the secure storage and use of radioactive materials.

Radioactive discharge

10.13 Wherever practical and permitted by law, radioactive materials will be dealt with by leaving them to decay until they have reached a safe or non-radioactive state. This requires the construction of storage facilities known as "decay stores". For longer-lived materials, some discharge into the drainage system of the hospital or into the air as a result of disposal by burning, in approved incinerators, will be necessary. Discharge to drains or into the air may also occur routinely in the use of radioactive materials or as a result of accidents.

10.14 The design of buildings within which radioactive materials are used must constrain their release into the outside environment to levels at or below predetermined levels agreed with the Environment Agency (EA). The EA has the responsibility for licensing such disposals under the Radioactive Substances Act 1993.

Environmental impact

10.15 The International Commission for Radiation Protection (ICRP) states that radioactive materials should only be used where there is no viable alternative. However, where their use cannot be avoided, the level of radioactive contamination of the environment, particularly watercourses into which radioactive fluids are discharged, must be monitored.

10.16 Dilution factors are critically important; if a discharge can be rapidly diluted by enabling a drain to join with others of larger flow and capacity, this will minimise radioactive concentrations and the associated hazards.

10.17 The RPA will give advice on the environmental impact and will be responsible for generating environmental impact models as needed.

10.18 When undertaking building design, the environmental impact of radioactive discharges should be considered at an early stage. Patients who have received unsealed radioactive materials will discharge these in the form of urine and other body fluids. Accordingly, the radioactive materials administered will be discharged over a short period of time, a few hours, into the drainage system.

10.19 Local limits for discharge will exist, and these should be carefully observed.

Decommissioning of facilities

10.20 Unsealed radioactive sources may give rise to chronic contamination of the rooms within which the sources are used, particularly the drainage system from those rooms (if discharge to drains is permitted). In this case, the RPA should be consulted and records examined to determine the nature of the radioactive materials present.

10.21 If the half-life is short, it may be wise to delay dismantling pipework etc for an appropriate period of time so that radioactive decay can effectively remove the hazard. Where the half-life is long or such delay cannot be accommodated, special precautions will be necessary and the pipework itself may constitute solid radioactive waste. Should this be the case, the RPA will write a decommissioning scheme of work and will also undertake to work with the EA to ensure appropriate ultimate disposal of the materials.

10.22 In respect of the decommissioning of contaminated sinks, drains etc there is a need for care if chemical agents, including bleach, are used to reduce the radioactive burden, since these may oxidise some radioactive materials in solution, rendering them insoluble. This may result in radioactive gases being released into the immediate environment – increasing the hazard to workers. Detailed professional advice must be obtained for each specific situation.

10.23 Most linear accelerators do not generate radioactive induction in the built environment or structures around them. Accordingly, for the majority of such installations, there are no special decommissioning criteria, and no special precautions need be taken in respect of radioactivity.

10.24 Linear accelerators operating at above 8.5 MV are capable of inducing radioactive activation in their own structures, most notably the collimators or jaws as well as parts of the couch. In very unusual instances, this activation may extend to the bunker shielding that surrounds the machine. Good design can virtually eliminate this problem.

10.25 When high-energy linear accelerator treatment rooms are being decommissioned, a radioactivity

site survey should be conducted and the RPA should be consulted as to whether or not special precautions are needed. It is unlikely that the move toward materials such as Ledite will materially affect radioactive activation, though the potential reuse of Ledite is a factor (see "Decommissioning costs" below).

Decommissioning costs

10.26 The decontamination and radiation control issues mentioned above are unlikely to add severely to decommissioning costs in radiotherapy facilities. However, the issue of disposing of large amounts of shielding does have a potential impact.

10.27 Reinforced concrete structures can only be removed following on-site breakage and demolition. Waste materials are then removed using heavy vehicles and disposed of by landfill or recycling, which involves crushing the material. Some shielding materials, for example Ledite, can be re-used by simply dismantling and returning to the supplier or redeploying in new buildings. Demolition costs should be considered as part of the business case for any new facility.

IT infrastructure

10.28 A robust IT infrastructure is essential to provide high-speed links capable of transferring large data files between the different pieces of equipment in the radiotherapy department. Access to secure data storage facilities is also essential.

Children's radiotherapy facilities

10.29 Only specialist designated centres will provide services for children.

10.30 Although throughput may not justify the provision of dedicated radiotherapy facilities, radiotherapy treatment rooms designated for paediatric use should be decorated to appeal to children.

10.31 If there is no local provision for the review of children, dedicated accommodation will be required within the radiotherapy unit.

10.32 A separate recovery room should be provided, in close proximity to the treatment room, for children treated under general anaesthetic or sedation.

10.33 "Play therapy" can reduce the need for sedation. This involves using toys and games, safely and in a friendly fashion, to reflect treatments the child may encounter. This should take place in a play therapy room, close to the treatment area.

10.34 In dedicated units, consideration should be given to the use of permanently-installed monitoring. CCTV observation is essential. Colour equipment must be used. Voice communication with the patient, accessible to parents/nurses etc, is very useful in reducing fear and gaining patient co-operation.

10.35 Children require access to HDR brachytherapy facilities so infrequently that the adult facility will always be used.

10.36 Unsealed source treatments present a particular challenge, given the need for a child-friendly yet specialised side ward environment which cannot be used for other purposes for much of the time due to radioactive contamination. The use of adult facilities is feasible but difficult in both nursing and social terms. The giving of such treatments on the open ward is unlikely to be lawful under the Ionising Radiations Regulations 1999. When the mandatory prior risk assessment is undertaken at the building design stage in conjunction with the RPA, the specific intended treatments must be taken into account to determine whether such treatments are appropriate for an open ward environment or whether a side-room is required.

10.37 See paragraph 10.8, 'Use of radiation'; 'Improving outcomes in children and young people with cancer' (NICE guidance); 'Improving outcomes in children and young people with cancer' (DH guidance).

Storage

10.38 Storage is required for the wide range of materials and tools used (for example plaster models, bandages and acetate), dependent on local requirements. Storage facilities should either be out of sight of patients or have doors. Items such as head and neck moulds that may be distressing for patients should not be stored on open shelves.

10.39 Body stereotactic radiotherapy generates a considerable demand for storage of body shells, which will require labelling and cataloguing. Early consultation with the project team will be essential to assess storage needs if stereotactic radiotherapy is proposed. The body shell will need to be kept for as long as the patient is receiving treatment and may, during this period, need replacing to allow for changes in the patient's body shape.

Functional relationships

Internal functional relationships

10.40 Figure 4 outlines the relationship between the various functions within a radiotherapy unit and reflects the care pathway set out above.

10.41 Interview and counselling room(s) should be located near to the entrance/exit of simulator and treatment rooms.

Relationships with other departments

10.42 A radiotherapy physics service is integral to the delivery of radiotherapy treatment. This Health Building Note describes the specific facilities required within the radiotherapy unit itself. However, good access is also required to the general medical physics/clinical engineering services housed elsewhere, within the medical physics department:

Medical physics (other than radiotherapy physics, including clinical engineering)

10.43 Radiotherapy facilities require good access to mechanical and electronics workshops for equipment maintenance undertaken in-house. Bespoke engineering devices may be required (for example plastic immobilising shells and supporting devices – which should be related to and incorporated in the mould room facilities).

Radiopharmacy unit

10.44 Some medical physics departments include a radiopharmacy unit. For guidance on the design of a radiopharmacy unit see Health Building Note (HBN) 14-01 – 'Medicines management: Pharmacy and radiopharmacy facilities'.

10.45 See paragraph 10.178, 'Radiotherapy physics and technology accommodation'.

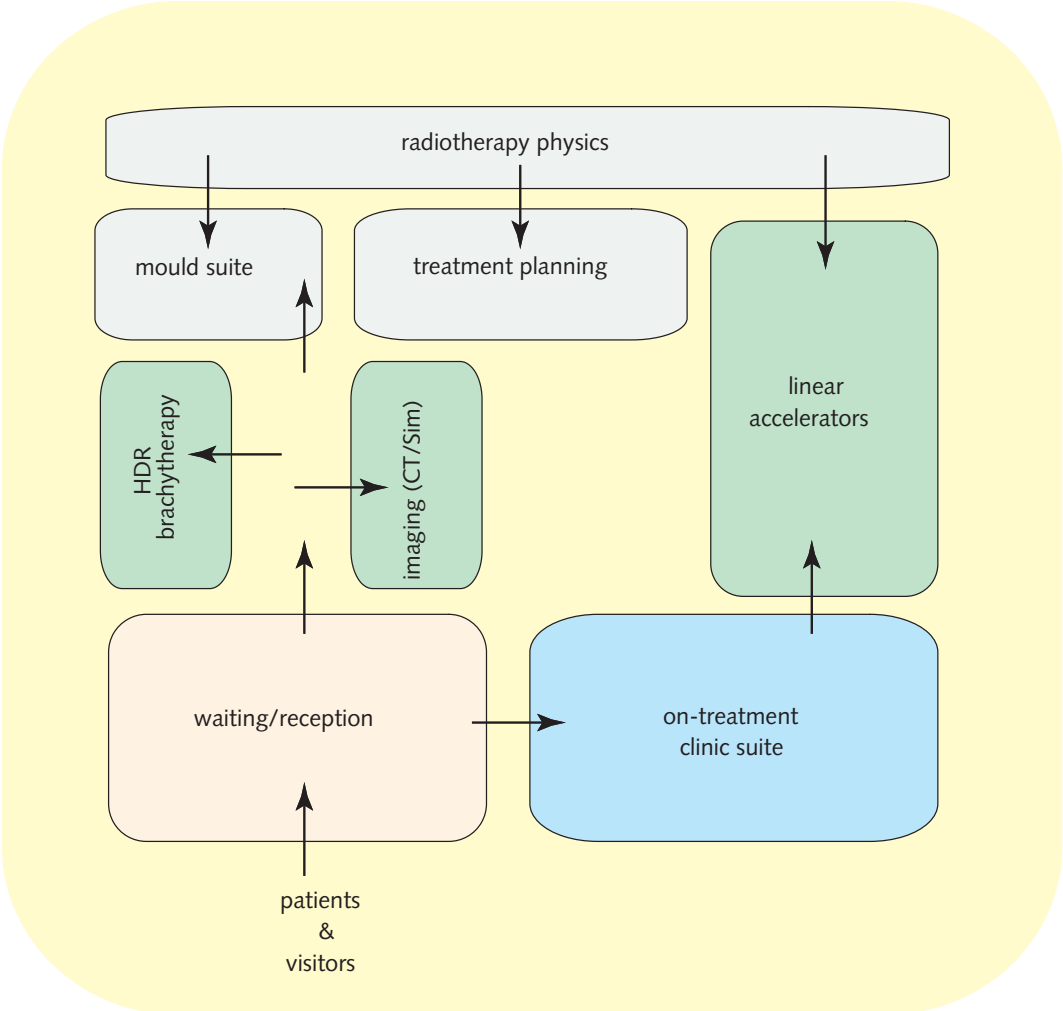


Figure 4 Radiotherapy unit: internal functional relationships

Public spaces

Reception/waiting area

10.46 The waiting area may need to accommodate in-patients arriving for treatment on beds and in wheelchairs with or without drip stands/oxygen cylinders attached, although experience in many recently built schemes indicates that this should be a project option as operational procedures may render it unnecessary.

10.47 See also 'Entrance, reception and waiting' in Health Building Note 00-03 – 'Clinical and clinical support spaces'.

On-treatment review suite

10.48 The on-treatment review suite comprises multi-purpose clinical rooms for the review and management of patients undergoing radiotherapy treatment, for example dietetic activities and discussions. The suite may also be used for the assessment of emergency patients.

10.49 Since patients may be attending on hospital trolleys, a trolley bay/waiting area should be provided.

10.50 An anaesthetic room is required if children are being treated on the unit.

Radiotherapy treatment suite

10.51 Teletherapy (external beam radiation treatment) is delivered by large machines (usually linear accelerators) situated within shielded facilities, the requirements for which are described in this section. Superficial/orthovoltage facilities may be provided as part of this suite and are also described here.

10.52 For guidance on the design of facilities for brachytherapy (internally delivered radiation treatment), see paragraph 10.117, 'HDR brachytherapy suite (optional)'.

Radiotherapy treatment rooms (linear accelerators)

10.53 Linear accelerators must be installed in purpose-designed treatment rooms (known as bunkers) with very heavy protective radiation shielding built into the construction.

10.54 These rooms should be large enough to allow easy access and movement of a patient on a bed, hoist, trolley or wheelchair. The design must also allow full clinical use and setup of all machines, including complete 360º rotation of gantries and tables. The entrance to the room should be wide enough to allow access for linear accelerators, large heavy components and subsequent replacement machines. Corner/wall protection against damage by equipment, wheelchairs, stretchers, beds etc should be provided, as should crash rails.

10.55 The entrance will usually comprise a shielded corridor or maze to prevent the escape of X-rays into the adjacent environment. Some designs feature heavy protective doors without the provision of a maze (usually because of space restrictions). Another option is to install a short maze with a half door (which will open more quickly than a full door).

10.56 The width of the primary barrier, the design of the entrance to the room, and the level of shielding above and below the linear accelerator, all depend on the design of the machine to be used, and the usage of adjacent rooms.

10.57 Access control gates and/or infrared beams/photoelectric cells must be provided to cut off/interlock to the machine.

10.58 Privacy and dignity issues should be considered, including siting of doors and/or entries into treatment rooms.

10.59 Environmental services usually gain access to the treatment room via the ceiling void of the maze. The effectiveness of shielding in the maze is often increased by concrete baffles. These should overlap to stop the direct path of radiation, but should be offset from each other and positioned in such a way as to allow services to weave through them.

10.60 The ceiling should be sufficiently strong, and there should be sufficient space above the false ceiling to allow for electrics for back-lit images and other technologies.

10.61 Trenches and floor chases for hidden cables and support frames will be extensive and will vary from one manufacturer to another. It may be possible to establish, through consultation with manufacturers, the extent and critical dimensions of these features. This information should be available to the design team at an early stage in the design process to allow the features to be incorporated into relevant drawings and to ensure that the integrity of fire compartmentation is not breached.

10.61 A floor trench between the wall of the treatment room and the control area is required to gather all services passing between the control area and the linear accelerator.

10.63 A duct will pass between the floor trench and a similar trench in the control area. The trench and ducts should not compromise the radiation shielding offered by the shielding walls or floor (in the case of a treatment room with radiation-sensitive areas beneath).

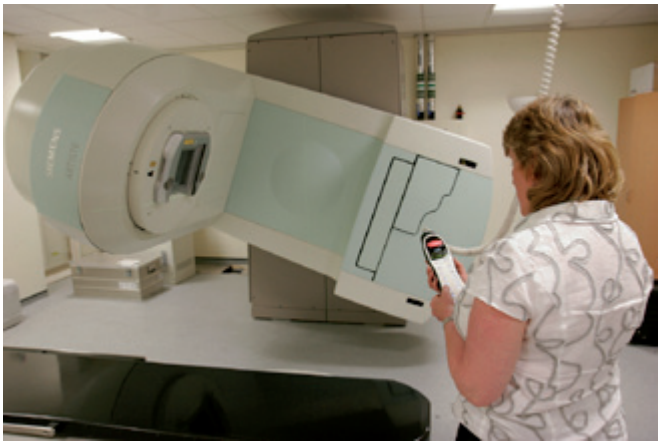
10.64 Radiotherapy treatments must be precise and accurate in terms of aiming the beam at the intended target. This requirement means that almost all linear accelerators use a base frame set into the floor that links the accelerator gantry to the patient support device or couch.

10.65 A recess is needed for the base frame and table floor; this will need to allow service connection back to the treatment machine base and floor trench.

10.66 A lifting beam could be located over the centre of the linear accelerator, or an A-frame crane could be used instead.

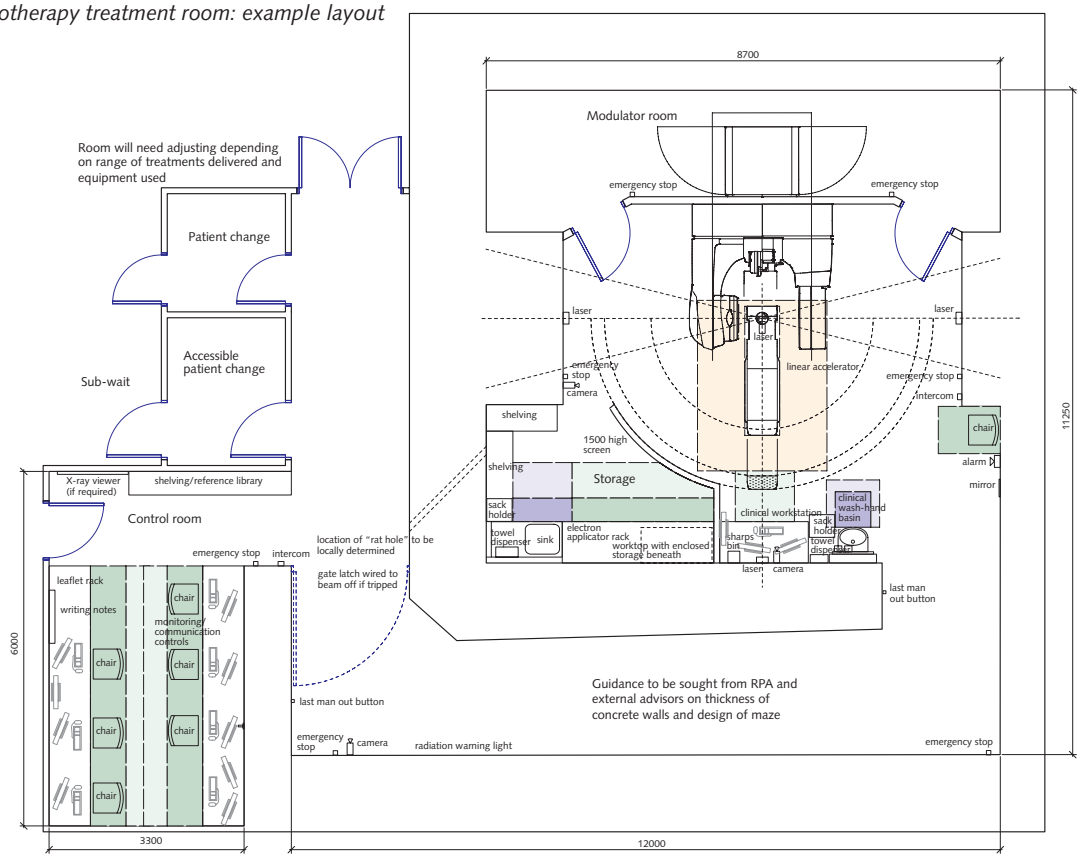
10.67 Supports are required for heavy ceiling-mounted equipment such as the frames of data monitors.

Linac machine (courtesy Derby Hospitals NHS Foundation Trust)



Clinician operating linac machine (courtesy Derby Hospitals NHS Foundation Trust)

Figure 5 Radiotherapy treatment room: example layout



Rigid support is needed for wall-mounted alignment lasers and ceiling lasers.

Storage facilities

10.68 Storage will be required for a wide range of medical equipment, the requirements to be determined in consultation with users and machine specialists. RPA advice is essential on the suitability of storage facilities; for example, metallic shelves may not be appropriate in some circumstances.

10.69 Bespoke storage facilities, repeated in each treatment room, will allow staff to move between rooms and work more efficiently, as they will be familiar with storage arrangements in each room.

10.70 Specialised storage is needed for immobilisation devices, vacuum bags and body casts.

10.71 Accessory equipment (for example breast boards, lung boards, electron applicators and their lead end pieces) should have dedicated storage, either in cupboards, on shelves or hanging.

10.72 Storage should be provided for total body irradiation (TBI) and stereotactic body radiation therapy (SBRT) equipment.

Other design features

10.73 The following facilities should also be provided in treatment rooms:

1. wall-mounted dispensers for paper towels, paper cups, soap, paper sheets etc;
2. wash-hand basin, shelf and mirror;
3. chair for patient;
4. coat hooks;
5. alignment lasers firmly bolted to structure, linked to laser generator using fibre-optic cable;
6. last-man-out button, located near entrance to maze (advice to be sought from the RPA and HSE);
7. safety sign and warning light at entrance to treatment room and within the room;
8. emergency stops for the linac;
9. music facilities;
10. CCTV cameras mounted at high level to monitor patient during unaccompanied periods;
11. two-way communication system between control area and treatment room;
12. access to IT, workstations and wireless connectivity.

10.74 The number of CCTVs required will depend on local practice. Closed-circuit televisions should have pan and zoom facilities and secrecy switches. They may be interlocked to the entry system to the maze, provided the interlock can be overridden from the control area.

Interior design of treatment rooms

10.75 The dominating nature of a linear accelerator and the mass of high-tech equipment presents a daunting experience for patients. Every opportunity should be taken with the interior design to create a pleasant, non-intimidating environment with a sense of order and reassurance. Lighting will play an important role.

10.76 Murals and paintings on walls and ceilings may provide welcome distraction. Consultation on artwork should begin at an early point in the design process. Care should be taken when positioning artwork to avoid obstructing patient support aids and the sightline of lasers. Artwork must not cover radiation warning lights or emergency stops.

Environmental and engineering considerations

10.77 Lighting will need to vary from subtle and non-glaring (for patient relaxation) to high-level (for maintenance tasks). It should be possible to dim the lighting. A spotlight is required at the foot of the couch/bed. Ventilation (number of air changes) must be adequate to remove ozone formed during treatment as well as for staff/patient comfort. Local variable temperature control is required. Access to chilled water is required for the operation of the linacs.

10.78 Particular consideration should be given to fire protection systems in linear accelerator treatment rooms, where patient movement may be compromised.

Other radiotherapy treatment suite spaces

Waiting area (optional)

10.79 Waiting areas may be provided either as sub-waits associated with a single or a pair of linacs or

centralised within one area, depending upon the size and layout of the unit.

10.80 If the trust's operational policy requires supervision/observation of the sub-wait areas, this may be provided from the linear accelerator control room, where the design solution permits.

Trolley waiting area (optional)

10.81 Where necessary, a trolley bay can be provided in an area easily observed by clinical staff and not closed off. Every effort should be made to ensure privacy and dignity; however, patient safety is of paramount importance.

Patient changing

10.82 Patient changing facilities should comprise separate lockable changing rooms adjacent to treatment/imaging rooms and positioned so others cannot see patients while changing or once they have changed.

10.83 A minimum of two changing rooms is required. One should be of sufficient size to permit changing for patients with a disability and those on stretchers/beds.

10.84 Ideally, patient changing rooms should be "pass through", with the patient entering on one side and exiting on the other into the imaging room. If a separate waiting area is provided for changed patients, gender separation should be ensured.

10.85 See also 'Changing facilities' in Health Building Note 00-02 – 'Sanitary spaces'.

Linear accelerator control areas

10.86 The number of computers, printers, keyboards, workstations etc will depend on local practice and choice of manufacturer.

10.87 Early consultation is recommended to establish equipment requirements and the equipment's position relative to the maze entrance and patient areas. Efficiency of patient observation, ease of staff movement, data protection and staff training requirements are key considerations.

10.88 Staff require easy access to the treatment room maze. They also need to be able to see members of the public approaching the maze entrance, while shielding from view the monitors displaying patient information.

10.89 The minimum depth of worktops should be 1000 mm to accommodate large computer monitors. This is being reviewed in view of the introduction of flat screens.

10.90 A minimum of 9000 mm length of worktop space will be required for each linear accelerator. There should be sufficient space between the control desk and wall to allow radiographers to move behind each other.

10.91 The requirement for X-ray viewing boxes and darkroom facilities will be determined locally.

10.92 Daylight in the control area is highly desirable, but monitors should not be subject to glare from direct sunlight.

10.93 A large number of sockets, computer network and telephone points will be required in the control areas. Trunking systems that offer flexibility and change may be appropriate.

10.94 Dosimetry and QA monitoring cables should run through "rat holes" and be terminated in suitable places in the control area and in the treatment room. There should be provision for two sets of dosimetry cables to: (a) provide some redundancy; and (b) facilitate cross-calibration of ion chambers against each other. The tunnel should be angled to ensure that it does not provide a direct path for any radiation.

Radiographer preparation room

10.95 There should be separate rooms adjacent to each control area where the following activities take place:

1. data preparation for treatment;
2. calculations;
3. image review and manipulation;
4. data transfer checking;
5. capturing initial set-up parameters.

10.96 If lack of space precludes provision of a separate room, the control area should be large enough to accommodate these functions, but this might prove distracting. Care should be taken to ensure that patients cannot hear clinicians' conversations or view screens with confidential information displayed.

Treatment planning room

10.97 Workstations should be located in quiet areas. Medical staff review portal images, treatment plans and outline volumes.

10.98 The workstations should be networked to the treatment planning system, PACs and record and verify system. The system should have access to data from the imaging modalities and brachytherapy equipment.

10.99 Electronic communication links are required to the supplier of the treatment planning system for "remote diagnostics testing" as part of service agreements.

10.100 Where paper treatment sheets are still used, these will be stored in the medical records department. Some storage may still be required for blank treatment sheets where these are written by hand.

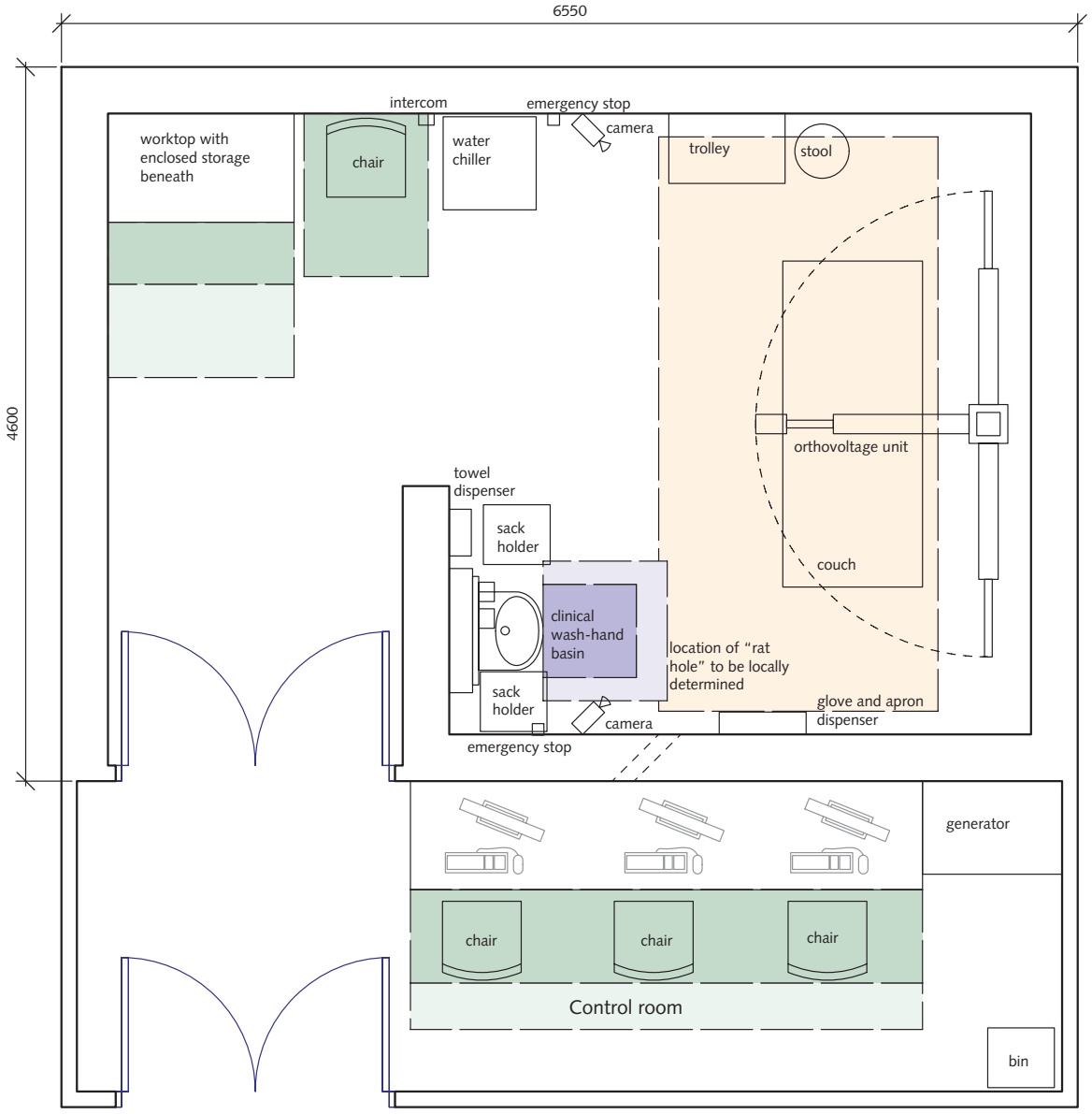
10.101 Film storage will depend on local practice.

Superficial/orthovoltage radiotherapy treatment facilities (optional)

Superficial/orthovoltage radiotherapy treatment room

10.102 An orthovoltage machine is more powerful than the superficial machine and gives out levels of energy that require concrete walls to protect the adjacent spaces, whereas a superficial machine only requires X-ray standard protection. Orthovoltage machines can be used at a lower output to deliver superficial treatments.

10.103 For full future flexibility, all rooms should ideally be sized and shielded to accommodate an



Guidance to be sought from RPA and external advisors on thickness of concrete walls and design of maze

Figure 6 Superficial/orthovoltage radiotherapy treatment room: example layout

orthovoltage machine. A small maze is a viable alternative to heavy door construction.

10.104 The X-ray tube should be mounted on a simple but robust floor or ceiling suspension and powered by a conventional X-ray generator system. Doors and viewing windows must be constructed with adequate radiation protection. CCTV may be used in addition, or as an alternative, to a window.

10.105 Rooms should be of sufficient size to allow all areas of the patient's body to be treated with the patient lying/sitting in a stable position.

10.106 They need to contain specialist shelving to house the beam-defining applicators.

10.107 Each room should contain a mobile treatment couch, spotlight, clinical wash-hand basin and patient wash-hand basin.

10.108 There should be an interlocked door between the treatment room and the control area.

Machine room: Superficial/orthovoltage

10.109 The requirements for this room are specific to the equipment manufacturer.

Control area: Superficial/orthovoltage

10.110 The number of computers, printers, keyboards, workstations etc will depend on local practice and choice of manufacturer.

10.111 Early consultation is recommended to establish equipment requirements and the equipment's position relative to the maze entrance and patient areas. Efficiency of patient observation, ease of staff movement, data protection and staff training requirements are key considerations.

10.112 Staff require easy access to the treatment room maze. They also need to be able to see members of the public approaching the maze entrance, while shielding from view the monitors displaying patient information.

10.113 The requirement for X-ray viewing boxes will be determined locally.

10.114 Daylight in the control area is highly desirable, but monitors should not be subject to glare from direct sunlight.

10.115 A large number of sockets, computer network and telephone points will be required in the control areas. Trunking systems that offer flexibility and change may be appropriate.

10.116 Dosimetry and QA monitoring cables should run through "rat holes" and be terminated in suitable places in the control area and in the treatment room. There should be provision for two sets of dosimetry cables to: (a) provide some redundancy; and (b) facilitate cross-calibration of ion chambers against each other. The tunnel should be angled to ensure that it does not provide a direct path for any radiation.

HDR brachytherapy suite (optional)

10.117 Prior to delivery of brachytherapy, an applicator or tube is inserted or implanted in the patient, often in a treatment room which has been constructed to undertake surgical procedures as well as brachytherapy. Where the implantation is performed in an operating theatre suite separate from the treatment room, the patient is taken on a trolley from theatre to either an MR or CT scanner and thence to the HDR suite.

10.118 This guidance assumes that the patient would be changed already from theatre, so patient changing facilities are not required as part of the suite.

10.119 A recovery room is required.

Functional relationships

10.120 The following diagram outlines the relationship between the various functions forming a HDR brachytherapy suite.

HDR brachytherapy treatment room

10.121 HDR treatment must be undertaken in a shielded room incorporating a small maze and/or a protective door. A dedicated treatment room may be located in the radiotherapy unit or may be associated with an operating theatre suite. Alternatively, treatment may be delivered in a linear accelerator treatment room within the radiotherapy unit. This reduces building and maintenance costs but interrupts the use of the linear accelerator.

10.122 Ideally, access to the room should be through the control room (see Figure 7). The security features required by the HASS regulations must be incorporated into the treatment room design. Two physical barriers are required: this can be achieved with a secure inner door and steel roller shutter outer door. A source exposed indicator should be sited on the rear wall of the room where it can be seen as the door opens.

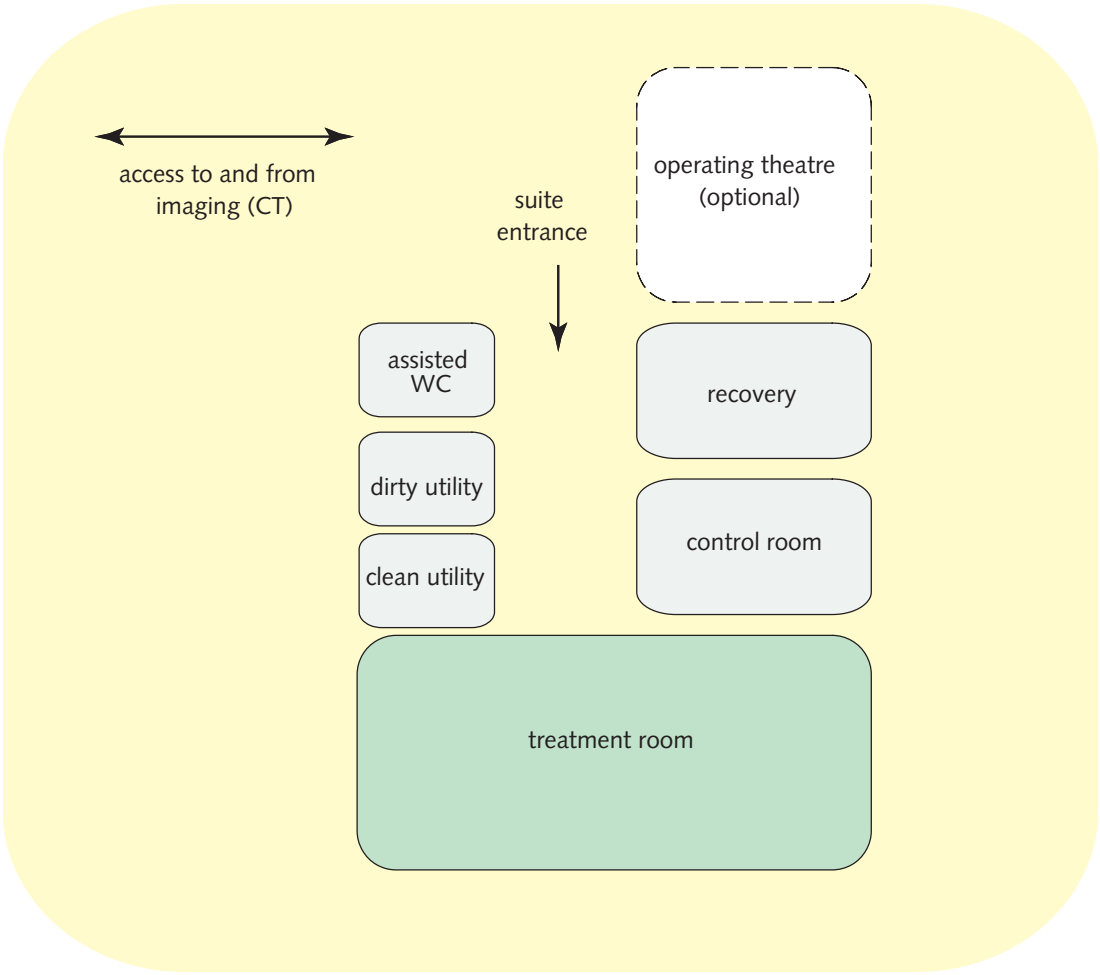


Figure 7 HDR brachytherapy: internal relationships

10.123 The size and design of the room should be appropriate for the procedures that are to be performed in the room. Procedures requiring extensive pre-cleaning and post-cleaning should be performed elsewhere, and the room should be used for treatment delivery only. If insertions are undertaken in the brachytherapy treatment room itself, it must be appropriately equipped for surgical procedures. The room should be large enough to allow access for fluoroscopy equipment and crash trolley if required. Space requirements for new procedures and technological developments should be considered.

10.124 Open worktop bench space should be provided, the length dependent on local requirements.

10.125 Oxygen and suction facilities are required.

10.126 A sink is required for the cleaning of equipment, along with a separate wash-hand basin for staff use.

10.127 Adequate storage should be provided outside the room for applicators, accessories and QA equipment so the room is easily cleanable and remains uncluttered.

10.128 Search (last man out) buttons should be positioned so the whole room can be seen by the operator upon actuating it.

HDR brachytherapy treatment space (courtesy Derby Hospitals Foundation Trust)

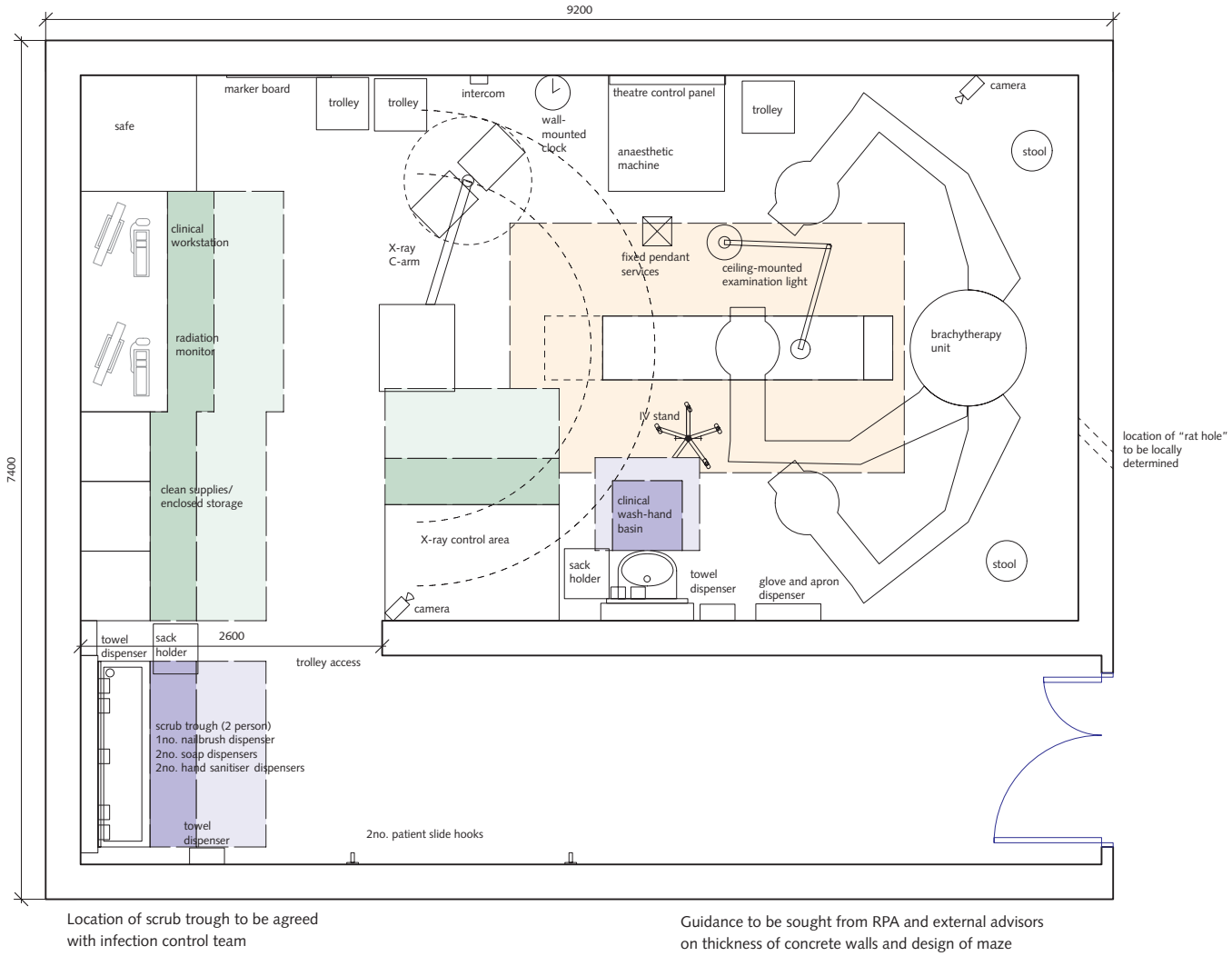


Figure 8 Brachytherapy room: example layout

Control area: Brachytherapy

10.129 A remote protected observation/control area will also be required. This provides safe monitoring of the entrance to the room. CCTV will be needed for patient observation. Intercom facilities between the treatment room and control area are required to permit direct communication with the patient during the treatment. A "rat hole" should be provided between the treatment room and control area, as described for the linear accelerator control room.

10.130 The number of computers, printers, keyboards, workstations etc will depend on local practice and choice of manufacturer.

10.131 Early consultation is recommended to establish equipment requirements and the equipment's position relative to the maze entrance and patient areas. Efficiency of patient observation, ease of staff movement, data protection and staff training requirements are key considerations.

10.132 Staff require easy access to the treatment room maze. They also need to be able to see patients approaching the maze entrance, while shielding from view the monitors displaying patient information.

10.133 The requirement for X-ray viewing boxes will be determined locally.

10.134 Daylight in the control area is highly desirable, but monitors should not be subject to glare from direct sunlight.

10.135 A data safe should be used to store source and treatment records.

10.136 A large number of sockets, computer network and telephone points will be required in the control areas. Trunking systems that offer flexibility and change may be appropriate.

10.137 Dosimetry and QA monitoring cables should run through "rat holes" and be terminated in suitable places in the control area and in the treatment room. There should be provision for two sets of dosimetry cables to: (a) provide some redundancy; and (b) facilitate cross-calibration of ion chambers against each other. The tunnel should be angled to ensure that it does not provide a direct path for any radiation.

Store: Sealed radioactive source

10.138 The function of this room is to provide a suitable environment for the receipt, storage and handling of solid or sealed radioactive materials. It should be located alongside the brachytherapy rooms.

10.139 The design must comply with the Health and Safety Executive's (HSE) approved code of practice 'Working with ionising radiation' and the High-activity Sealed Radioactive Sources and Orphan Sources Regulations 2005 (the 'HASS Regulations').

10.140 An area will be needed for recording radioactive materials in stock and in transient use. Storage will be required for shielded containers used for transporting radioactive materials and for applicators and accessories in regular use.

10.141 If preparation and handling of radioactive sources takes place in the unit, a shielded work bench may be required, normally constructed using lead. Because of the weight of lead shielding needed, localised floor loading will be abnormal and will need to be taken into account, either by design of the structure or by siting.

10.142 A storage safe is required for the sealed sources. The preparation varies with the treatment requirement, but will always include an assay of the radioactivity present and may involve source sterilization.

Imaging suite

Waiting area

10.143 If the trust's operational policy requires supervision/observation of the sub-wait areas, this may be provided from the imaging control room, where the design solution permits. See also 'Waiting area' in Health Building Note 00-03.

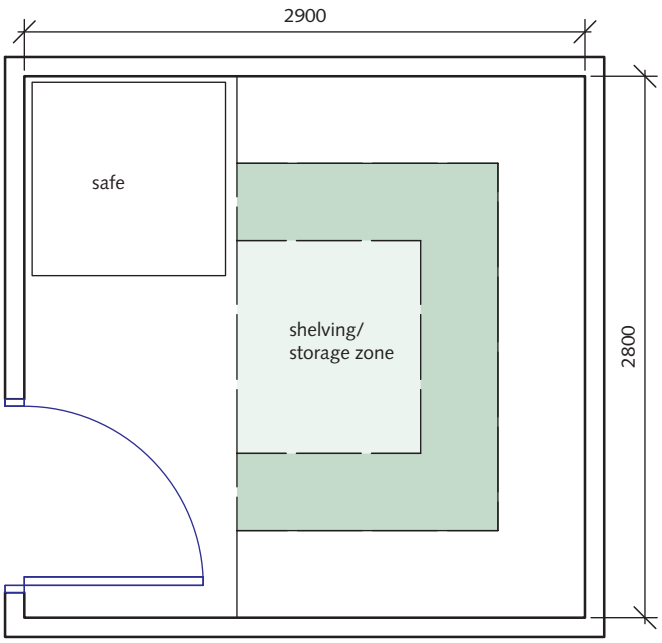


Figure 9 Sealed radioactive source store: example layout

Patient changing

10.144 Patient changing facilities should comprise separate lockable changing rooms adjacent to treatment/imaging rooms and positioned so others cannot see patients while changing or once they have changed.

10.145 A minimum of two changing rooms is required. One should be of sufficient size to permit changing for patients with a disability and those on stretchers/beds.

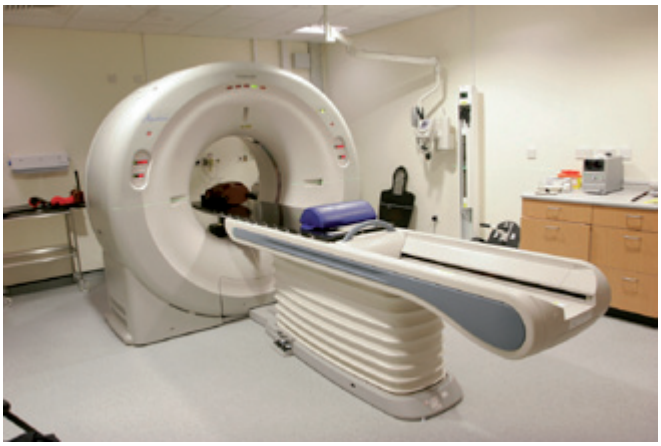
10.146 Ideally, patient changing rooms should be "pass through", with the patient entering on one side and exiting on the other into the imaging room. If a separate waiting area is provided for changed patients, gender separation should be ensured. See also 'Changing facilities' in Health Building Note 00-03.

Imaging room(s)

10.147 The design of an individual room is dependent on the type of imaging device to be installed but must include adequate protection measures against hazards.

10.148 Orthogonal lasers are an essential component of any imaging room to facilitate the positioning of patients.

10.149 The orientation of the imaging device within the room will depend on the space and local preference, but easy access is required to the



CT scanner (courtesy Derby Hospitals NHS Foundation Trust)

couch by trolleys, beds, a portable hoist and wheelchairs.

10.150 Facilities must include injection facilities and, depending upon local operational policies, anaesthetic gases.

10.151 Dedicated storage is required in cupboards, on shelves or hanging for accessory equipment (for example phantoms, QA devices, immobilisation devices) and a range of couch tops.

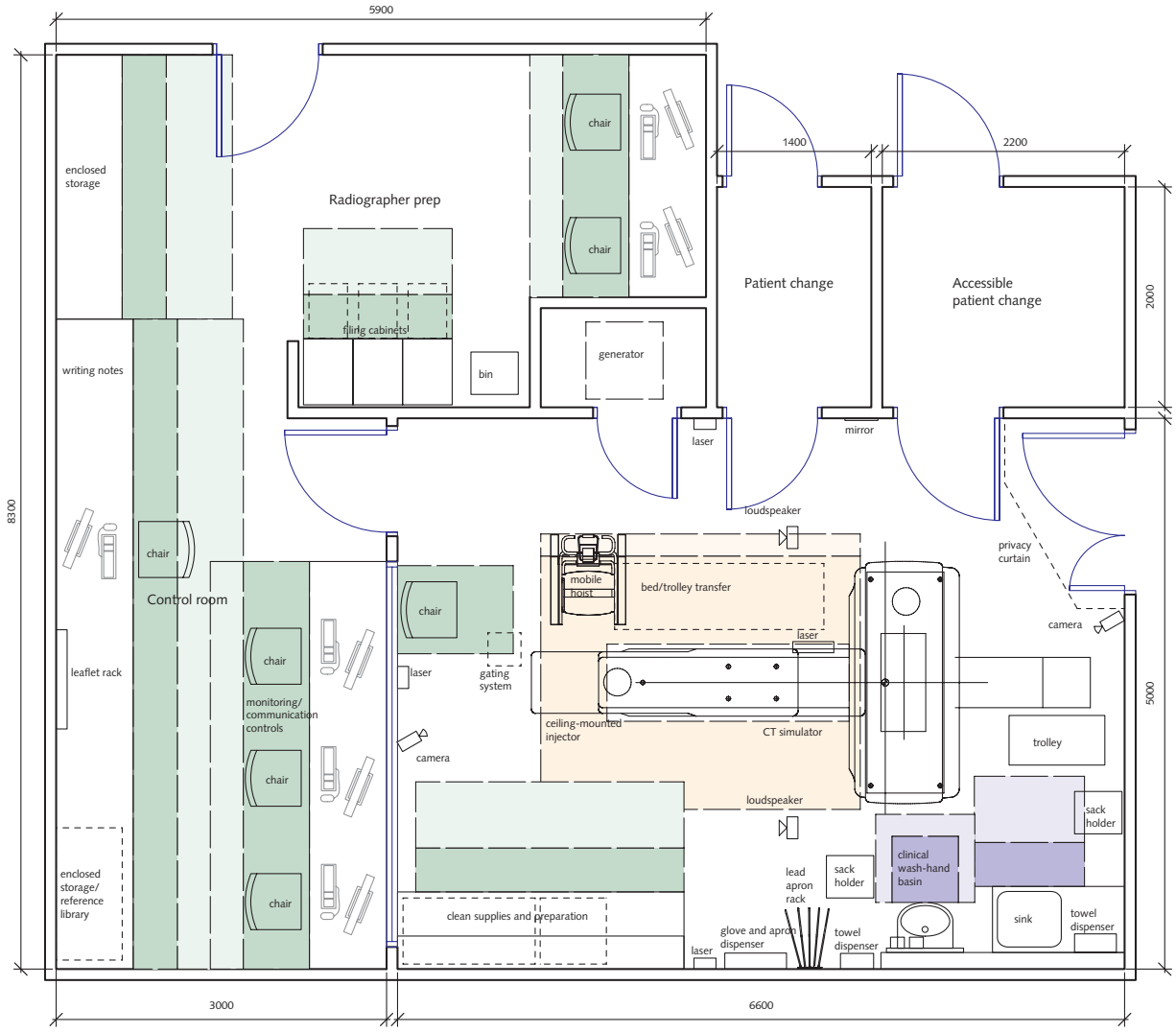
10.152 The position of the viewing window should provide the best possible view of the patient during the imaging procedure and the equipment as it moves by remote control. CCTV should be provided to enable the patient to be viewed at all times during a procedure.

10.153 See Health Building Note 6, 'Facilities for diagnostic imaging and interventional radiology', for the design requirements, including shielding.

Generator room

10.154 The requirements for this room are specific to the equipment manufacturer.

Figure 10 Imaging room: example layout

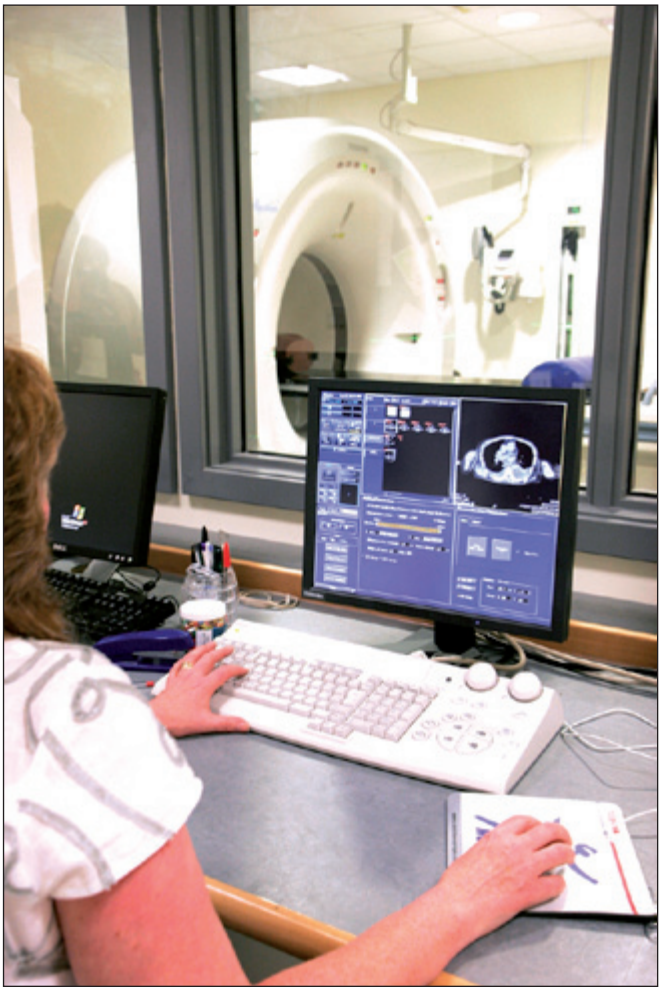


Imaging control area(s)

10.155 There should be a closed control area adjacent to each imaging room with access to the imaging room and patient changing facilities. The area should include an appropriately shielded viewing window. The design of the control area should be appropriate to the imaging modality and local practice.

10.156 Adequate workbench space with network points should be allocated for the workstations and imaging device monitors and to permit local clinical practice. This will include consideration of viewing of images and data from PACS systems, electronic patient management systems and manipulation of data acquired during individual imaging sessions.

10.157 Other requirements include a telephone, cupboards/drawers/shelving for storage, a lockable cupboard for drugs, and space for storage of contrast media in an appropriate temperature-controlled environment.



Imaging control area (courtesy Derby Hospitals NHS Foundation Trust)

Radiographer preparation room

10.158 There should be separate rooms adjacent to each control area where the following activities take place:

a. data preparation for treatment;

b. calculations;

c. image review and manipulation;

d. data transfer checking;

e. capturing initial set-up parameters.

10.159 If lack of space precludes provision of a separate room, the control area should be large enough to accommodate these functions. Care should be taken to ensure that patients cannot hear clinicians' conversations or view screens with confidential information displayed.

Imaging clinical preparation room

10.160 A clinical room is required for the preparation of patients requiring barium, catheterisation and other pre-imaging clinical procedures. It should include facilities to store, prepare, dispense and clear away drinks etc.

Mould suite

Impression and fitting room

10.161 It will frequently be necessary to immobilise the patient to ensure the safe and accurate delivery of teletherapy. To achieve this, a mask is custom-made from various materials, for example thermoplastics or thin plastic sheets (PETG), to match the patient's features. This is fitted onto the patient and registered to the treatment couch, thus restricting patient movement during treatment.

10.162 To align the part of the body to receive radiation treatment, it may be necessary to support a particular limb or other part of the body. This may be achieved using vacuum bags or foam blocks, which are available as standard items or may need to be specially produced, to be decided locally.

10.163 A room is required for the manufacture of immobilisation shells or supporting devices, providing wheelchair/bed access. The patient will usually need to remove clothing, therefore changing facilities within an adjoining room area will be needed.

10.164 The process may be lengthy and unpleasant, and may involve taking impressions. To ease the process for the patient, the room should offer a light, airy environment and be as comfortable as possible. Ceilings may be designed with some point of interest to relieve patients' boredom. Background music may also be considered. Seating should be provided for relatives or carers accompanying patients. The provision of a WC in the vicinity of the mould suite should also be considered.

10.165 A dentist's chair and height-adjustable couch may be required. The dignity of the patient should be considered when locating the couch in relation to doors. Relocatable frames will be required when using stereotactic techniques instead of shells.

10.166 A wash-hand basin, mirror, shelf, seat and coat hooks will also be required.

10.167 If plasterwork is undertaken, a plaster sink with splash-back will be required in addition to the patient wash-hand basin. For guidance on the design of plaster sinks see 'Sanitary assemblies'.

10.168 A hot-water bath, with filling and draining facilities, will be required for use of thermoplastics.

10.169 Locally adjustable heating and ventilation should be provided to control local heat gain and odours.

10.170 The floor covering should be non-slip linoleum or vinyl with coved skirting for ease of cleaning.

10.171 Alignment lasers should be fitted in the mould room at the same height as those in the linear accelerator treatment rooms.

10.172 Technicians will need to view imaging data and carry out clerical work and reporting. A workstation should be provided with a computer network point, sockets, telephone and filing cabinet.

10.173 See also Health Building Note 00-02 'Sanitary spaces'.

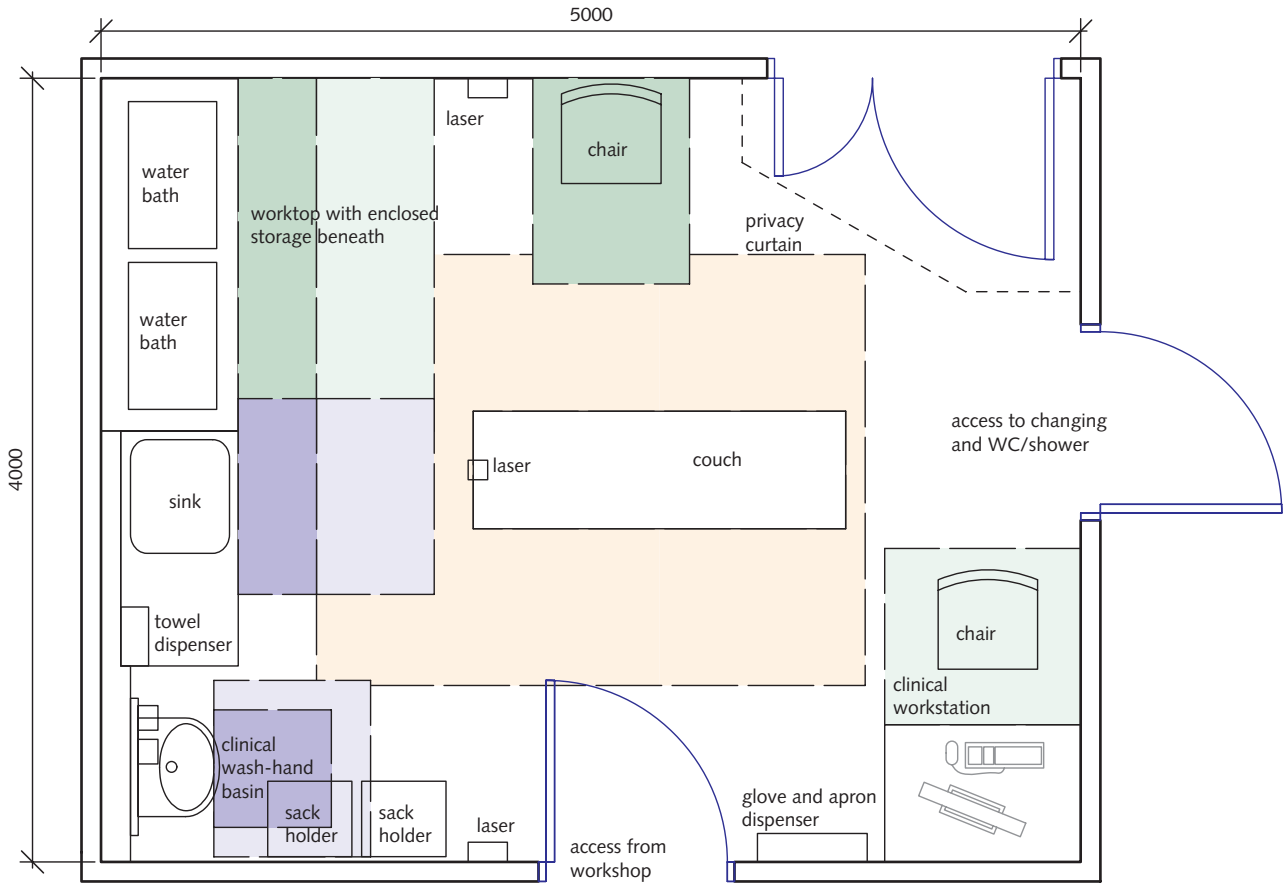


Figure 11 Impression and fitting room: example layout

Patient changing

10.174 Ideally, patient changing rooms should be "pass through", with the patient entering on one side and exiting into the mould room. See also 'Changing facilities' in Health Building Note 00-03.

Workshop

10.175 The requirements for the workshop will depend on the range of immobilisation solutions provided by the centre. It should have adequate bench space and be divided into clean and dirty (plaster) areas. Open shelving/storage in the room should be kept to a minimum owing to dust levels in the workshop. A laboratory gas supply should be provided as the heat source for tools required for plastics work.

10.176 Where the range includes custom-made beam directional shells, a vacuum-forming machine, plaster sink and plaster work area will be required. (Vacuum-formers produce significant heat, which should be considered in the planning.) Where plasterwork is performed, local dust extraction should be provided. An equipment sink and wash-hand basin are required. Non-slip flooring should be used throughout.

10.177 A laser should be provided above a clean work area for setting up shells etc (wax bolus, lead masks, wax blocks etc).

Radiotherapy physics and technology accommodation

10.178 The following radiotherapy physics and technology accommodation should be provided within the radiotherapy unit itself, as a minimum, for undertaking equipment maintenance and repairs and contributing to quality assurance:

a. electronics workshop/laboratory;

b. office accommodation: as a minimum desk space for two engineers;

c. stores, including a bulky equipment store.

10.179 Optional facilities, depending on access to the main medical physics facilities, may include:

a. mechanical workshop and machine room;

b. dosimetry laboratory;

c. offices for radiation protection, research and imaging physicists, depending on the configuration of services in the individual trust.

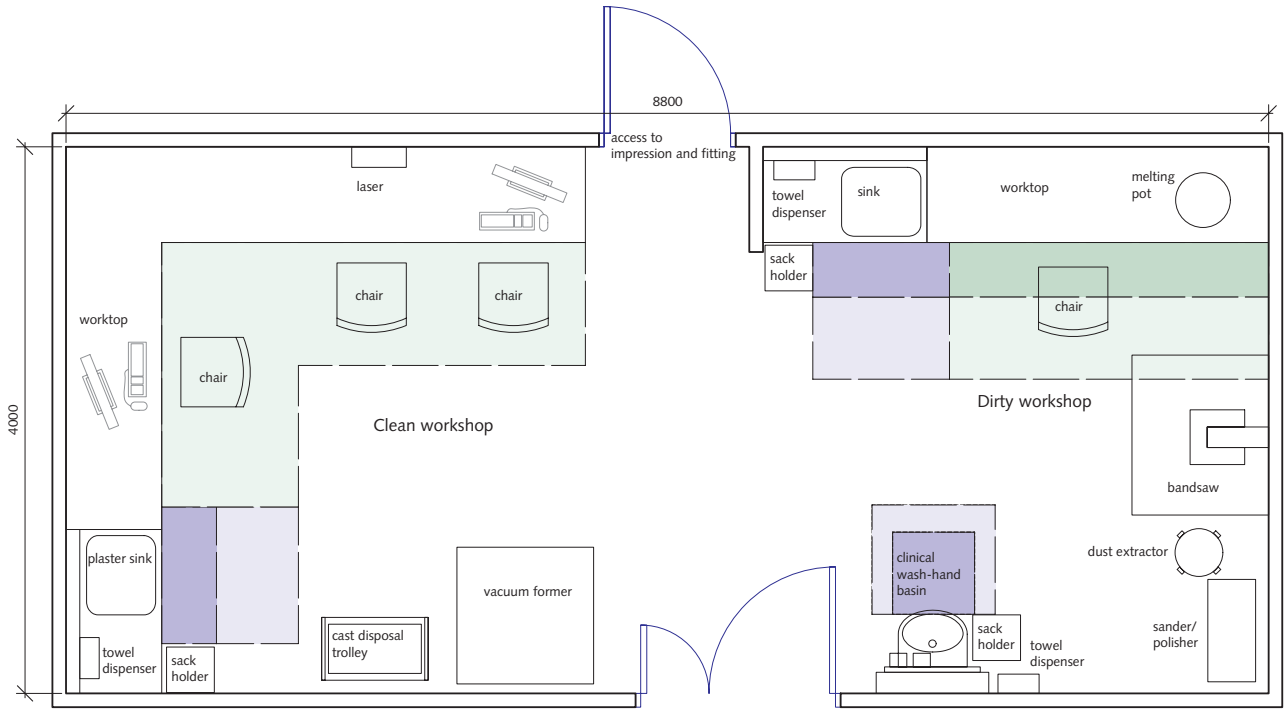


Figure 12 Workshop: example layout

Electronics workshop/laboratory

10.180 A clean, dust-free environment is important, as is good-quality general lighting, with task lighting at workbenches. Natural lighting and ventilation is preferable, although solar control and mechanical ventilation may be needed to maintain suitable working temperatures.

10.181 Other requirements include:

a. generous benching with cupboards and drawers underneath;

b. bench-mounted trunking to provide adequate power outlets;

c. desk space to perform record-keeping and logs;

d. shelves and bookcases for manuals and records;

e. telephone and computer workstation.

Offices

10.182 Consideration should be given to the tasks undertaken in offices, which will require access to the IT network for treatment plan review and approval, access to high-quality X-ray, CT/MR images through PACS or the radiotherapy archive, and access to the radiotherapy record and verify/scheduling system as well as standard NHS and office software. Standard telecommunications are required. Space is also required for QA equipment and mobile devices.

Stores

10.183 Storage facilities should be large enough to accommodate large items such as dosimetry plotting tanks and other large QA and calibration equipment items, and A-frame lifting devices. They should also be provided with hooks and racking to store a range of spares, components and cables.

Mechanical workshop and machine room (optional)

10.184 Equipment will vary depending on local requirements, but is likely to include:

a. vacuum-forming machine with compressor;

b. contouring device;

c. electric furnace and oven;

d. saws (including bandsaws);

e. bench drill and grinder;

f. bench sander and polisher;

g. wax bath;

h. various hand-held tools;

j. bunsen burner;

k. workbenches;

m. storage cupboards;

n. compressed air outlet;

p. wall-mounted viewing boxes;

q. telephone and computer workstation;

r. plaster trap sink.

10.185 The construction and layout of equipment and work areas must meet the requirements of current health and safety regulations. Storage will be needed for tools. Facilities will be required for lifting heavy objects, for example an overhead rail and hoist.

10.186 Flooring should be non-slip and oil-resistant. Wall finishes should be robust.

10.187 Good natural and artificial lighting is required, with task lighting at workstations. Solar control and mechanical ventilation will be needed. An air extract system should be provided to remove fumes and dust caused by welding, sanding etc.

10.188 Access for deliveries by lorry should be considered.

10.189 A floor gulley will be required.

10.190 Storage shelves for smaller devices, spares and phantoms should be incorporated – metal racking would be suitable. Electrical sockets are required for those items needing to be charged.

Dosimetry laboratory

10.191 Equipment will vary depending on local requirements but is likely to include:

a. dosimetry system;

b. bench-mounted oven for dosimetry work;

c. safe;

d. laboratory workbenches;

e. storage cupboards;

f. telephone and computer workstations.

11 In-patient facilities

Assessment suite

11.1 Facilities may be provided for the assessment of patients for treatment-related toxicity and/or progression of disease symptoms. The patient's condition may have deteriorated while in the department or they may have been brought in as an emergency case. The patient may subsequently be admitted to a main ward.

11.2 The unit comprises a four-bed bay with workstations for medical and nursing staff and a controlled drugs cupboard.

11.3 Assessment units should be capable of delivering gender separation with the use of solid partitions as appropriate.

Ward accommodation

11.4 Project teams should refer to the generic guidance on adult in-patient accommodation.

11.5 Patients suffering from cancer and undergoing cancer treatments often do not wish to eat at prescribed times. They may have very specific dietary requirements or difficulties with eating. Operational policies and the design of ward spaces and catering facilities should take this into account.

11.6 Rest rooms and refreshment facilities for visitors/carers should be located nearby. Overnight accommodation may be required.

Specialist in-patient accommodation

11.7 Treatment rooms for pulse dose rate brachytherapy and for unsealed source brachytherapy will be provided as part of the oncology in-patient accommodation, comprising specialised shielded bedrooms with shielded en-suites.

11.8 The en-suite facilities associated with these rooms must also feature a specially designed soil drainage system to cope with radioactive urine and faeces.

PDR treatment room

11.9 The level of shielding required will depend on dose regimes. The nature and location of any windows must be the subject of a specific risk assessment at the planning stage, taking into account external adjacencies, occupation levels, and the intended scope and frequency of usage of the PDR equipment. The advice of local RPAs must be sought.

11.10 Intercom communication is required, along with CCTV for patient observation. Television monitors should be located so as to preserve privacy while permitting observation by nurses.

11.11 The control panel should be mounted in a secure location outside the treatment room and duplicated on the machine itself. The use of independent radiation monitors is advised.

11.12 See also paragraph 10.8, 'Use of radiation'.

Treatment room – unsealed source brachytherapy

11.13 The enclosing structure should be heavily shielded to prevent radiation passing from the room into the surrounding areas. It will typically consist of concrete in the order of 500 mm thick, with shielding doors, alongside use of electronic patient monitoring.

1.14 Good design and use of shadow shields will allow patients to have visitors on a limited basis and will allow greater contact with nurses. Some advanced designs also incorporate a window and use external shielding as a garden feature. This may require controlled outside access.

11.15 Intercom communication with the patient is required.

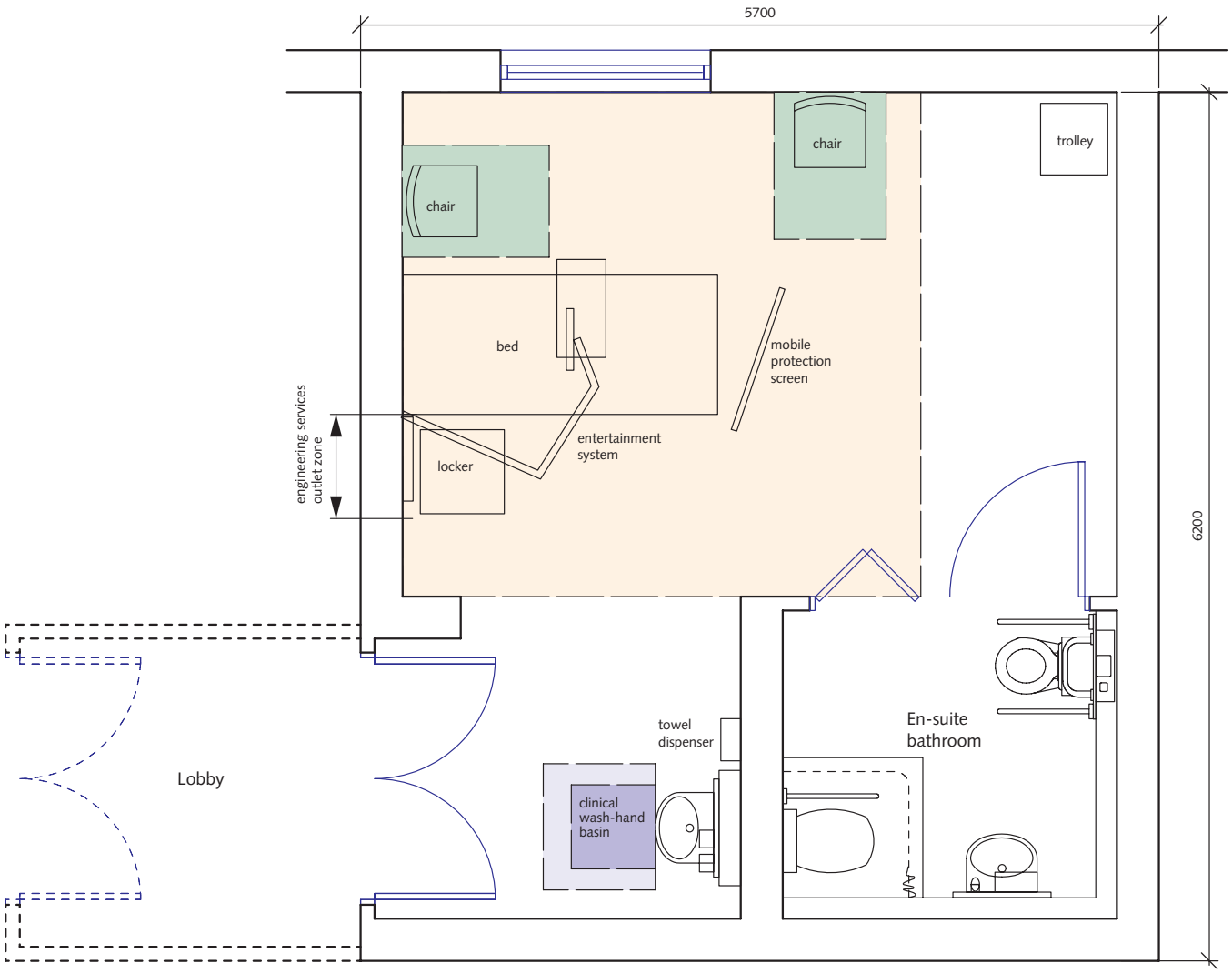
11.16 A washing machine, washing-up sink and clinical wash-hand basin for use by staff are required to help prevent spread of contamination.

11.17 Surfaces should be impermeable and easy to clean, with careful attention to jointing. Sinks should resist permanent contamination, particularly if

used for waste disposal. Wash-hand basins should be ceramic, with lever- or sensor-operated taps.

11.18 The risk of spillages (where radioactive drinks are used) and radioactive contamination influences the choice of surface finishes; for example, stainless steel is inappropriate due to the irremovable nature of iodine contamination.

11.19 Articles, materials or equipment that are contaminated with radiation will need to be collected in a shielded container and stored in a contaminated articles store until the radiation has fallen to a safe level.



Treatment room – unsealed source brachytherapy: example layout

12 Oncology operating theatres

12.1 Project teams should refer to the generic guidance on operating theatres (Health Building Note 26, 'Facilities for surgical procedures').

12.2 Particular attention should be paid to the need for mobile C-arm or image intensifier access and use. Special storage facilities for catheters, guide wires etc will be needed. These should be within or immediately adjacent to the operating room.

12.3 Where cervical and other Class 3 laser treatment procedures are undertaken, the guidance from the Medicines and Healthcare Products Regulatory Agency (MHRA) should be followed. This includes special power supplies for laser equipment, reduced use or elimination of polished surfaces, and the provision of window blinds, laser safety signs etc. The laser radiation protection advisor (LRPA) must be consulted on theatre design, the declaration of a laser-controlled area and the provision of warning lights etc.

12.4 See also DB 2008(03) 'Guidance on the safe use of lasers, IPL systems and LEDs'.

13 Engineering considerations

13.1 Specific requirements should be formulated in discussion with both end-users and manufacturers of specialist equipment. Some issues, particularly those related to radiation safety, will require specific and detailed discussion with other professional consultants, including the RPA.

13.2 All mechanical and electrical services entering rooms designed to contain radiation must be routed through specially-designed access ports so that shielding is not compromised. It may also be necessary to incorporate changes in the direction of ductwork, pipework and cable containment systems to provide protection against radiation breakout. In general, all services into linear accelerators will pass through the maze, with possibly an additional chicane for high-energy linear accelerators.

13.3 In treatment and simulation areas, plant and services access arrangements must not compromise the radiological protection provided for these rooms. Consideration should be given to the comfort and safety of patients as well as that of both clinical and maintenance staff.

13.4 In addition to any "permit to work" system (see 'Space required for plant and distribution systems' under 'General') it may be appropriate with low-level radiation hazard systems to use a "double knock" system whereby attempted unauthorised access to service areas at first initiates an audible warning and only when the access attempt is continued is radiation-emitting equipment switched off.

13.5 However, the hazard levels present with therapy equipment require a more stringent approach in which any intrusion will trigger beam shutdown.

General

Space required for plant and distribution systems

13.6 Particular care should be taken to ensure that where maintenance areas are subject to the effects of radiation and are not fully protected, for example plant areas above radiotherapy treatment rooms, appropriate access control procedures including "permit to work" and warning lights are incorporated as part of the maintenance procedure.

Design for safety

13.7 The Ionising Radiation (Medical Exposure) Regulations 2000 and associated codes of practice place onerous requirements upon engineering aspects of design and operational practices in cancer care facilities. There are additional requirements from the Radioactive Substances Act 1993 in respect of storage, use and disposal of radioactive materials. The RPA and custodian of radioactive substances must be consulted.

Acoustics

13.8 Prolonged periods of silence or near-silence can be as distressing as noise to a patient undergoing cancer treatment. Consideration should be given to the provision of a source of low-level sound, for example background music, in treatment spaces such as radiotherapy treatment rooms.

Commissioning of engineering services

13.9 It will be necessary to commission engineering services to radiotherapy treatment rooms, particularly those related to ventilation, prior to the installation and commissioning of radiotherapy equipment. Accordingly, appropriate integration of the building services commissioning schedule with the equipment supplier's installation and commissioning schedule should be undertaken at an early stage.

Resilience of electrical supplies

Emergency electrical supplies

13.10 The emergency generator providing electricity in the event of a main supply failure should be capable of providing full (100%) back-up including air-conditioning and comfort cooling

plant serving specialist equipment such as linacs. If a new generator is to be installed, this should be the solution of preference.

13.11 In the event of a main supply or local final circuit failure, linear accelerator treatment rooms and escape routes should be illuminated by self-contained, battery-powered luminaires charged continuously from the main supply and capable of providing illumination for a period of three hours.

Small power distribution systems

13.12 Systems in medical locations and associated areas should comply with the special requirements of BS 7671:2008 'Requirements for electrical installations. IEE Wiring Regulations' (17th edition) and the Institution of Engineering and Technology (IET) publication Guidance Note 7 'Special Locations' (3rd edition). The electrical supply connections to all medical electrical equipment should comply with BS EN 60601-1-2 'Medical electrical equipment. Particular requirements for the basic safety and essential performance of high frequency surgical equipment and high frequency surgical accessories'.

13.13 The earth connection at the power termination should be suitable for the functional earth requirements specified by the radiology equipment manufacturer and arranged to receive a direct connection from the earth reference terminal, which should be provided or designated in every radiotherapy treatment room.

Mechanical engineering services

Ventilation

13.14 The majority of areas within cancer facilities will require mechanical ventilation due to equipment heat gains, patient/staff numbers and for clinical/radiology reasons.

13.15 The possibility of excessive heat emission from equipment such as linear accelerators, and the special and often prolonged nature of radiotherapy procedures, will usually require that the air supply to radiotherapy treatment rooms be mechanically cooled.

13.16 Designers should consult with users, manufacturers and engineers to ensure an appropriate temperature is achieved. Where deep-planning of other continuously occupied spaces (for example linac/simulator control rooms or linac bunkers) is unavoidable, there will also be occasions when acceptable levels of comfort can only be maintained by air-cooling.

Ventilation cooling systems

13.17 Refrigeration loads for ventilation systems should be met either by the hospital's central water chiller plant or by packaged, remotely located, water chiller plant dedicated to the cancer facility. Direct expansion systems are not advocated unless the refrigeration load is small, since they can only be controlled in steps, unlike chilled water, which can be continuously modulated. Such equipment may be provided by the manufacturers of specialist equipment and should be considered differently from general ventilation cooling.

Ventilation controls

13.18 The indicators for a system serving a particular space should be both immediately adjacent to the space and at a central staff base. For specialist equipment such as simulators/linacs, the indication should be located in the associated control room.

Steam

13.19 The requirement for steam within the facility will be limited to humidification equipment associated with special ventilation plant to equipment spaces. If available, steam from the hospital's main supply should be used, subject to the requirement for clean steam as set out in Health Technical Memorandum 03-01 – 'Specialised ventilation for healthcare premises', Part A: Design and validation.

13.20 In the absence of a central steam supply, local steam generators, preferably powered from a firm gas supply, should be employed. Electrical generation of steam should only be considered in isolated instances where other forms of generation are unavailable.

Drainage requirements – chemical and radioactive contaminated effluent

13.21 Providing that there is adequate dilution and the silver content has been effectively recovered, effluent can be discharged into the internal drainage system. Project teams are advised to establish the acceptable levels for silver and other processing chemicals at the planning stage of a scheme, as these are subject to change.

13.22 At an appropriate early stage in the design process, the project proposals for the collection and discharge of chemical and radioactive contaminated effluent should be discussed and verified with the local Radiation Protection Advisor and the local utility company responsible for the local authority sewerage system. Appropriate restrictions on access to drains and sewers likely to be discharging radioactive material must be implemented through "permit to work" type systems and locked drainage covers.

Lighting systems

13.23 Consideration should be given to dynamic lighting control systems that alter the visual quality (but not the intensity) of light over the day to mimic natural daylight patterns and improve wellbeing. This is of particularly importance in areas without good natural daylight.

Lighting (treatment rooms)

13.24 For linear accelerators and some other treatment machines, automatic switching to low-level room lighting will be needed to facilitate the use of field marker lights and low-power alignment lasers. Conversely, high levels of lighting are needed for equipment maintenance.

Illuminated warning signs

13.25 At the entrance to each radiotherapy treatment room (except entrances used only by patients under the direct control of staff already inside the room, for example those from walk-through changing cubicles), an illuminated safety sign and a warning lamp must be provided in order to comply with the statutory requirements for radiological protection.

13.26 A further warning lamp must be provided in the treatment room.

13.27 The warning lamps must give a clear indication in red when they are energised, and the illuminated signs should incorporate the legend "Do not enter", visible only when illuminated.

13.28 Other illuminated signs may also be required within the facility. All such signs should be connected to essential supplies where necessary. For therapy equipment, where exclusion of persons other than the patient is essential, the warning systems must work with interlocks and be specifically approved by the RPA.

Fire detection and alarm systems

13.29 While fire detectors throughout the facility in general may be of the normal ionisation type, detectors within radiotherapy treatment rooms require special consideration.

CCTV systems (medical)

13.30 CCTV should be provided where required to monitor patients undergoing treatment in restricted areas. The interference to which such equipment may be subject, such as radiation levels within the linac bunker, should be taken into account when it is specified, to ensure acceptable electromagnetic compatibility. Care should be taken in the positioning of monitors in order to preserve patient privacy.

Patient/staff and staff emergency call systems

13.31 Particular care should be taken when choosing and siting call systems for use while a patient is undergoing treatment, for example within a linear accelerator.

14 Schedules of accommodation

14.1 The schedules of accommodation include the following examples:

a. a chemotherapy service serving a population of 400,000;

b. a radiotherapy service comprising two linear accelerators;

c. a radiotherapy service comprising four linear accelerators.

Example schedules of accommodation for 'Cancer treatment facilities'

ADB data for rooms without codes will be available later in the year

Cost guide allowances:	Circulation and communication	Engineering
Public	35.0%	25.0%
Clinical	35.0%	38.0%
Staff	35.0%	23.0%

Example 1: Chemotherapy service in an acute hospital

ADB code	Room name/function	Unit area allowance	Quantity	Net internal area	Circulation and communication allowance	Engineering allowance	Gross internal area	Notes
	Public spaces for chemotherapy unit							
	Entrance, reception and visitors' facilities							
J0232	Reception desk (size based on number of places)	5.5	2	11.0	3.9	2.8	17.6	2 places per unit
J1155/J1414	Waiting area: 25 places	2.25	25	56.3	19.7	14.1	90.0	Includes children's play area and 10% wheelchair places. 1 per treatment place (rounded to 25)
M0727	Interview room: 7 places	12.0	1	12.0	4.2	3.0	19.2	1 per unit
H1131	Information/resource area: 3 person	12.0	1	12.0	4.2	3.0	19.2	1 per unit
V1131	Nappy changing room	5.0	1	5.0	1.8	1.3	8.0	1 per unit
S0012	Infant feeding room	6.0	1	6.0	2.1	1.5	9.6	1 per unit
V1121	WC: semi-ambulant	2.5	2	5.0	1.8	1.3	8.0	1 per 12 waiting places
V0922	WC: independent wheelchair	4.5	1	4.5	1.6	1.1	7.2	1 per unit
	Clinical spaces for on-treatment suite							
J1255/J1414	Waiting area: 6 places	2.25	6	13.5	4.7	5.1	23.4	Includes children's play area and 10% wheelchair places. 0.75 per clinical room
C0522	Examination/physical therapy room	12.0	4	48.0	16.8	18.2	83.0	1 per 100,000 population
C0237	Consulting/examination room: double sided couch	16.0	4	64.0	22.4	24.3	110.7	1 per 100,000 population
	Dispensary: non-chemotherapy drugs	8.0	1	8.0	2.8	3.0	13.8	1 per unit
T0535	Clean utility room	16.0	1	16.0	5.6	6.1	27.7	1 per unit
Y0431	Dirty utility room	8.0	1	8.0	2.8	3.0	13.8	1 per unit
T0211	Staff communication base (size based on number of places)	5.5	2	11.0	3.9	4.2	19.0	2 places per unit
M0727	Interview room: 7 places	12.0	1	12.0	4.2	4.6	20.8	1 per unit
W1594	Store: linen	3.0	1	3.0	1.1	1.1	5.2	1 per unit
W1584	Store: equipment and consumables	8.0	1	8.0	2.8	3.0	13.8	1 per unit
	Clinical spaces for chemotherapy treatment suite							
	Chemotherapy treatment: multi-chair bay	10.0	20	200.0	70.0	76.0	346.0	1 per 20,000 population
X1500	Chemotherapy treatment: single room	12.0	4	48.0	16.8	18.2	83.0	1 per 100,000 population
	Chemotherapy preparation room	16.0	1	16.0	5.6	6.1	27.7	1 per unit
V0922	WC: independent wheelchair	4.5	4	18.0	6.3	6.8	31.1	En-suite to chemotherapy treatment single rooms
J1264	Parking bay: trolley/bed	4.0	2	8.0	2.8	3.0	13.8	2 per unit
T0535	Clean utility room	16.0	1	16.0	5.6	6.1	27.7	1 per unit
Y0431	Dirty utility room	8.0	1	8.0	2.8	3.0	13.8	1 per unit
T0211	Staff communication base (size based on number of places)	5.5	2	11.0	3.9	4.2	19.0	One staff base of 2 places provided per 6 chairs, as the open-plan space is to be subdivided into bays of no more than 6 for privacy and gender separation
T0211	Staff communication base (size based on number of places)	5.5	2	11.0	3.9	4.2	19.0	One staff base of 2 places provided per 6 chairs, as the open-plan space is to be subdivided into bays of no more than 6 for privacy and gender separation
T0211	Staff communication base (size based on number of places)	5.5	2	11.0	3.9	4.2	19.0	One staff base of 2 places provided per 6 chairs, as the open-plan space is to be subdivided into bays of no more than 6 for privacy and gender separation
V1121	WC: semi-ambulant	2.5	4	10.0	3.5	3.8	17.3	1 per 6 treatment places
V0922	WC: independent wheelchair	4.5	2	9.0	3.2	3.4	15.6	1 per 12 treatment places
V1635	Shower room: assisted	8.0	1	8.0	2.8	3.0	13.8	1 per unit
W1594	Store: linen	3.0	1	3.0	1.1	1.1	5.2	1 per unit
W1584	Store: equipment and consumables	12.0	1	12.0	4.2	4.6	20.8	1 per unit
W0274	Store: fluids	12.0	1	12.0	4.2	4.6	20.8	1 per unit
	Chemotherapy prep area	16.0	1	16.0	5.6	6.1	27.7	1 per unit
	Staff spaces: shared support							
Y1510	Cleaners' room	8.0	2	16.0	5.6	3.7	25.3	2 per unit
P0625	Pantry/refreshment area	8.0	1	8.0	2.8	1.8	12.6	1 per unit
Y0646	Disposal hold: 3000 litres	12.0	1	12.0	4.2	2.8	19.0	1 per unit
G0180-01	Parking bay: resuscitation trolley	2.0	1	2.0	0.7	0.5	3.2	1 per unit
M0251	Office: 1-person	8.0	3	24.0	8.4	5.5	37.9	3 per unit
M0252	Office: 2-person	12.0	1	12.0	4.2	2.8	19.0	1 per unit
M0278/M0281/ M0410/M0731	Admin area: shared use (size based on number of workstations)	6.6	6	39.6	13.9	9.1	62.6	6 places per unit
H11304-01	Seminar room: 10 places	19.0	1	19.0	6.7	4.4	30.0	1 per unit
D0434-01	Rest room with mini kitchen (size based on number of seats)	1.9	10	19.0	6.7	4.4	30.0	10 place per unit
V1010	WC: ambulant	2.0	1	2.0	0.7	0.5	3.2	1 per unit
	Total allowance			**873.9**	**305.8**	**294.5**	**1474.2**	
	Optional accommodation							
	Staff changing facilities (if not provided centrally elsewhere)							
V0554-03/V0667/ V0725/V1321	Changing area: staff (size based on number of lockers)	1.4	33	46.2				Includes uniform exchange area, showers and a number of individual changing rooms. Based on 30 staff who need a locker (allowing for shift changeover), plus a 10% contingency to allow for male/female split (suggested apportionment 2/3 female to 1/3 male)
V0725	Changing room: semi-ambulant	2.0	1	2.0				Additional individual changing room to allow for male and female segregation
V1321	Shower room: ambulant	2.5	1	2.5				Additional shower room to allow for male and female segregation
V1010	WC: ambulant	2.0	2	4.0				Additional WC to allow for gender segregation

Relationship of schedule to ADB room names

Relationship of schedule to ADB for scalable rooms (ie those for which a recommended room size does not exist)

Optional accommodation

Circulation, communication and engineering services allowances

Example schedules of accommodation for 'Cancer treatment facilities'

ADB data for rooms without codes will be available later in the year

	Cost guide allowances	Circulation and communication	Engineering
Public		35.0%	25.0%
Clinical		35.0%	38.0%
Staff		35.0%	23.0%

Example 2: Radiotherapy service in an acute hospital: two linear acceleators

ADB code	Room name/function	Unit area allowance	Quantity	Net internal area	Circulation and communication allowance	Engineering allowance	Gross internal area	Notes
	Public spaces for radiotherapy unit							
	Entrance, reception and visitors' facilities							
J0232	Reception desk (size based on number of places)	5.5	2	11.0	3.9	2.8	17.6	2 places per unit
J1155/J1414	Waiting area: 15 places	2.25	15	33.8	11.8	8.4	54.0	Includes children's play area and 10% wheelchair places
H1131	Information/resource area: 3 person	12.0	1	12.0	4.2	3.0	19.2	
V1131	Nappy changing room	5.0	1	5.0	1.8	1.3	8.0	This space may be considered optional if facilities are provided centrally nearby
S0012	Infant feeding room	6.0	1	6.0	2.1	1.5	9.6	This space may be considered optional if facilities are provided centrally nearby
V1121	WC: semi-ambulant	2.5	2	5.0	1.8	1.3	8.0	1 per 12 waiting places. 2 provided for gender separation
V0922	WC: independent wheelchair	4.5	1	4.5	1.6	1.1	7.2	1 per unit
G0180-10	Parking bay: wheelchair	2.0	1	2.0	0.7	0.5	3.2	1 per unit
	Clinical spaces for on-treatment review suite							
J1255/J1414	Waiting area: 6 places	2.25	6	13.5	4.7	5.1	23.4	Includes children's play area and 10% wheelchair places
X0145	Treatment room	16.0	1	16.0	5.6	6.1	27.7	1 per unit
C0237	Consulting/examination room: double sided couch access	16.0	2	32.0	11.2	12.2	55.4	1 per bunker
T0538	Clean utility room without controlled drugs cupboard	8.0	1	8.0	2.8	3.0	13.8	1 per unit
Y0431	Dirty utility room	8.0	1	8.0	2.8	3.0	13.8	1 per unit
T0211-01	Staff communication base (size based on number of places)	5.5	1	5.5	1.9	2.1	9.5	1 place per 2 bunkers
M0727	Interview room: 7 places	12.0	1	12.0	4.2	4.6	20.8	1 per unit
W1594	Store: linen	3.0	1	3.0	1.1	1.1	5.2	1 per unit
W1584	Store: equipment and consumables	8.0	1	8.0	2.8	3.0	13.8	1 per unit
	Clinical spaces for radiotherapy treatment suite							
	Radiotherapy treatment room (bunker) and maze	160.0	2	320.0	112.0	121.6	553.6	The overall size has been determined on the assumption that the walls are concrete. The size will be less if using a modular block system. 2 bunkers per satellite unit
	Control area serving radiotherapy treatment room	20.0	2	40.0	14.0	15.2	69.2	1 per bunker
H0105	Radiographer prep room	10.0	2	20.0	7.0	7.6	34.6	1 per bunker
V0725	Changing room: semi-ambulant	2.0	2	4.0	1.4	1.5	6.9	1 per bunker
V0726	Changing room: independent wheelchair	4.5	2	9.0	3.2	3.4	15.6	1 per bunker
V0922	WC: independent wheelchair	4.5	1	4.5	1.6	1.7	7.8	1 per unit
J1255/J1414	Waiting area: 12 places	2.25	12	27.0	9.5	10.3	46.7	Includes children's play area and 10% wheelchair places. 6 places per linac
	Treatment planning room	5.0	8	40.0	14.0	15.2	69.2	4 places per bunker
	Radiotherapy physics room	12.0	1	12.0	4.2	4.6	20.8	1 per unit
	Clinical spaces for imaging suite							
J1255/J1414	Waiting area: 6 places	2.25	6	13.5	4.7	5.1	23.4	Includes children's play area and 10% wheelchair places
V0725	Changing room: semi-ambulant	2.0	1	2.0	0.7	0.8	3.5	Dual access required. 1 per imaging room
V0726	Changing room: independent wheelchair	4.5	1	4.5	1.6	1.7	7.8	Dual access required. 1 per imaging room
V0922	WC: independent wheelchair	4.5	1	4.5	1.6	1.7	7.8	1 per imaging room
	Imaging room	33.0	1	33.0	11.6	12.5	57.1	1 per unit
	Generator room		1	0.0	0.0	0.0	0.0	Contained within engineering allowance
	Imaging control area	25.0	1	25.0	8.8	9.5	43.3	1 per imaging room
H0105	Radiographer preparation room	8.0	1	8.0	2.8	3.0	13.8	1 per imaging room
	Staff spaces: shared support							
Y1510	Cleaners' room	8.0	2	16.0	5.6	3.7	25.3	2 per unit
P0625	Pantry/refreshment area	8.0	1	8.0	2.8	1.8	12.6	1 per unit
G0180-01	Parking bay: resuscitation trolley	2.0	1	2.0	0.7	0.5	3.2	1 per unit
Y0646	Disposal hold: 3000 litres	12.0	1	12.0	4.2	2.8	19.0	1 per unit
M0251	Office: 1-person	8.0	1	8.0	2.8	1.8	12.6	1 per unit
M0252	Office: 2-person	12.0	2	24.0	8.4	5.5	37.9	1.5 per bunker
M0278/M0281/ M0410/M0731	Admin area: shared use (size based on number of workstations)	6.6	4	26.4	9.2	6.1	41.7	4 per bunker
H1313-01	Seminar room: 15 places	25.0	1	25.0	8.8	5.8	39.5	1 per unit
W1585-02	Store: general	8.0	1	8.0	2.8	1.8	12.6	En-suite to seminar room for flexibility in use of room
D0434-01	Rest room with mini kitchen (size based on number of seats)	1.9	10	19.0	6.7	4.4	30.0	5 places per bunker
V1010	WC: ambulant	2.0	2	4.0	1.4	0.9	6.3	1 per bunker
K0915	IT server room	6.0	1	6.0	2.1	1.4	9.5	1 per unit
W1584	Store: equipment and consumables	24.0	1	24.0	8.4	5.5	37.9	Stationery, equipment etc. 1 per unit
W1594	Store: linen	3.0	1	3.0	1.1	0.7	4.7	1 per unit
	Total allowance			**937.7**	**328.2**	**318.2**	**1584.0**	
	Optional accommodation							
	Staff changing facilities (if not provided centrally elsewhere)							
V0554-03/V0667/ V0725/V1321	Changing area: staff (size based on number of lockers)	1.4	33	46.2				Includes uniform exchange area, showers and a number of individual changing rooms. Based on 30 staff who need a locker (allowing for shift changeover), plus a 10% contingency to allow for male/female split (suggested apportionment 2/3 female to 1/3 male)
V0725	Changing room: semi-ambulant	2.0	1	2.0				Additional individual changing room to allow for male and female segregation
V1321	Shower room: ambulant	2.5	1	2.5				Additional shower room to allow for male and female segregation
V1010	WC: ambulant	2.0	2	4.0				Additional WC to allow for gender segregation
	Mould suite							
	Impression and fitting	20.0	1	20.0				
V0726	Changing room: independent wheelchair	4.5	1	4.5				
V1323	Shower room: semi-ambulant: standing use	5.0	1	5.0				
	Workshop	35.0	1	35.0				

Relationship of schedule to ADB room names
Relationship of schedule to ADB for scalable rooms (ie those for which a recommended room size does not exist)
Optional accommodation
Circulation, communication and engineering services allowances

Example schedules of accommodation for 'Cancer treatment facilities'

ADB data for rooms without codes will be available later in the year

	Cost guide allowances:	Circulation and communication	Engineering
Public		35.0%	25.0%
Clinical		35.0%	38.0%
Staff		35.0%	23.0%

Example 3: Radiotherapy service in an acute hospital: four linear accelerators (main centre)

ADB code	Room name/function	Unit area allowance	Quantity	Net internal area	Circulation and communication allowance	Engineering allowance	Gross internal area	Notes
	Public spaces for radiotherapy unit							
	Entrance, reception and visitors' facilities							
J0232	Reception desk (size based on number of places)	5.5	2	11.0	3.9	2.8	17.6	2 places per unit
J1155/J1414	Waiting area: 25 places	2.25	25	56.3	19.7	14.1	90.0	Includes children's play area and 10% wheelchair places
M0724	Interview room: 4 places	8.0	1	8.0	2.8	2.0	12.8	1 per unit
H1131	Information/resource area: 3 person	12.0	1	12.0	4.2	3.0	19.2	1 per unit
V1131	Nappy changing room	5.0	1	5.0	1.8	1.3	8.0	1 per unit
S0012	Infant feeding room	6.0	1	6.0	2.1	1.5	9.6	1 per unit
V1121	WC: semi-ambulant	2.5	2	5.0	1.8	1.3	8.0	1 per 12 waiting places
V0922	WC: independent wheelchair	4.5	1	4.5	1.6	1.1	7.2	1 per unit
G0180-10	Parking bay: wheelchair	2.0	1	2.0	0.7	0.5	3.2	1 per unit
	Clinical spaces for on-treatment review suite							
J1255/J1414	Waiting area: 12 places	2.25	12	27.0	9.5	10.3	46.7	Includes children's play area and 10% wheelchair places. The waiting areas may be combined together, design permitting
J1264	Parking bay: trolley/bed	4.0	2	8.0	2.8	3.0	13.8	1 per unit
X0145	Treatment room	16.0	1	16.0	5.6	6.1	27.7	1 per unit
C0237	Consulting/examination room	16.0	4	64.0	22.4	24.3	110.7	1 per bunker
T0538	Clean utility room without controlled drugs cupboard	8.0	1	8.0	2.8	3.0	13.8	1 per unit
Y0431	Dirty utility room	8.0	1	8.0	2.8	3.0	13.8	1 per unit
T0211	Staff communication base (size based on number of places)	5.5	2	11.0	3.9	4.2	19.0	1 place per 2 bunkers
M0727	Interview room: 7 places	12.0	1	12.0	4.2	4.6	20.8	1 per unit
W1594	Store: linen	3.0	1	3.0	1.1	1.1	5.2	1 per unit
W1584	Store: equipment and consumables	8.0	1	8.0	2.8	3.0	13.8	1 per unit
	Clinical spaces for radiotherapy treatment suite							
	Radiotherapy treatment room (bunker) and maze	160.0	5	800.0	280.0	304.0	1384.0	One room provided as a spare to facilitate flexibility and planned expansion. The overall size has been determined on the assumption that the walls are concrete. The size will be less if using a modular block system. 4 linacs per 100,000 population
	Control area serving radiotherapy treatment room	20.0	5	100.0	35.0	38.0	173.0	1 per bunker
H0105	Radiographer prep room	10.0	5	50.0	17.5	19.0	86.5	1 per bunker
V0725	Changing room: semi-ambulant	2.0	5	10.0	3.5	3.8	17.3	1 per bunker
V0726	Changing room: independent wheelchair	4.5	5	22.5	7.9	8.6	38.9	1 per bunker
V0922	WC: independent wheelchair	4.5	2	9.0	3.2	3.4	15.6	2 per unit
J1255/J1414	Waiting area: 12 places	2.25	12	27.0	9.5	10.3	46.7	Includes children's play area and 10% wheelchair places. One space planned between 2 bunkers if design permits; otherwise 1 no. 6 person wait per bunker
J1255/J1414	Waiting area: 12 places	2.25	12	27.0	9.5	10.3	46.7	Includes children's play area and 10% wheelchair places. One space planned between 2 bunkers if design permits; otherwise 1 no 6 person
J1255/J1414	Waiting area: 6 places	2.25	6	13.5	4.7	5.1	23.4	1 no 6 person wait per bunker
	Treatment planning room	5.0	20	100.0	35.0	38.0	173.0	4 places per bunker
	Clinical spaces for imaging suite							
J1255/J1414	Waiting area: 12 places	2.25	12	27.0	9.5	10.3	46.7	The waiting areas may be combined together, design permitting
V0725	Changing room: semi-ambulant	2.0	1	2.0	0.7	0.8	3.5	Dual access required. 1 per imaging room
V0726	Changing room: independent wheelchair	4.5	1	4.5	1.6	1.7	7.8	Dual access required. 1 per imaging room
V0922	WC: independent wheelchair	4.5	1	4.5	1.6	1.7	7.8	1 per imaging room
M0727	Interview room: 7 places	12.0	1	12.0	4.2	4.6	20.8	1 per imaging room
	Imaging room	33.0	1	33.0	11.6	12.5	57.1	1 per unit
	Generator room		1	0.0	0.0	0.0	0.0	Contained within engineering allowance
	Imaging control area	25.0	1	25.0	8.8	9.5	43.3	1 per imaging room
H0105	Radiographer preparation room	8.0	1	8.0	2.8	3.0	13.8	1 per imaging room
X0145	Imaging clinical preparation room	16.0	1	16.0	5.6	6.1	27.7	1 per imaging room
	Mould suite							
	Impression and fitting	20.0	1	20.0	7.0	7.6	34.6	1 per unit
V0726	Changing room: independent wheelchair	4.5	1	4.5	1.6	1.7	7.8	1 per impression/fitting room
V1323	Shower room: semi-ambulant: standing use	5.0	1	5.0	1.8	1.9	8.7	1 per impression/fitting room
	Workshop	20.0	1	20.0	7.0	7.6	34.6	1 per unit
	Dirty workshop	15.0	1	15.0	5.3	5.7	26.0	The example drawing combines this with the clean workshop to maximise space. 1 per unit
W1584	Store: equipment and consumables	8.0	1	8.0	2.8	3.0	13.8	1 per unit
	Radiotherapy physics and technology							
	Electronics workshop/laboratory	16.0	1	16.0	5.6	6.1	27.7	1 per unit
M0251	Office: 1 person	8.0	2	16.0	5.6	6.1	27.7	2 per unit
M0278/M0281/ M0410/M0731	Admin area: shared use (size based on number of workstations)	6.6	4	26.4	9.2	10.0	45.7	4 per unit
W1584	Store: equipment and consumables	8.0	1	8.0	2.8	3.0	13.8	1 per unit
	Staff spaces: shared support							
Y1510	Cleaners' room	8.0	2	16.0	5.6	3.7	25.3	2 per unit
P0625	Pantry/refreshment area	8.0	1	8.0	2.8	1.8	12.6	1 per unit
G0180-01	Parking bay: resuscitation trolley	2.0	1	2.0	0.7	0.5	3.2	1 per unit
Y0646	Disposal hold: 3000 litres	12.0	1	12.0	4.2	2.8	19.0	1 per unit
M0251	Office: 1-person	8.0	2	16.0	5.6	3.7	25.3	2 per unit
M0252	Office: 2-person	12.0	2	24.0	8.4	5.5	37.9	2 per unit
M0278/M0281/ M0410/M0731	Admin area: shared use (size based on number of workstations)	6.6	6	39.6	13.9	9.1	62.6	1.5 per linac
H1304-02	Seminar room: 20 places	31.0	1	31.0	10.9	7.1	49.0	1 per unit
W1585-02	Store: general	8.0	1	8.0	2.8	1.8	12.6	En-suite to seminar room for flexibility in use of room
D0434-02	Rest room with mini kitchen (size based on number of seats)	1.9	20	38.0	13.3	8.7	60.0	5 places per bunker
V1010	WC: ambulant	2.0	4	8.0	2.8	1.8	12.6	1 per bunker
K0915	IT server room	8.0	1	8.0	2.8	1.8	12.6	1 per unit
W1584	Store: equipment and consumables	32.0	1	32.0	11.2	7.4	50.6	Stationery, equipment etc. 1 per unit
W1594	Store: linen	3.0	1	3.0	1.1	0.7	4.7	1 per unit
	Total allowance			**1950.3**	**682.6**	**690.0**	**3322.8**	

	Optional accommodation							
N0317	Anaesthetic room	19.0	1	19.0				Required if children are attending
J1414-01	Play therapy room	20.0	1	20.0				Required if children are attending
J1264	Parking bay: trolley/ bed	4.0	2	8.0				
	Assessment bay: 4 bed	64.0	1	64.0				
	Radiotherapy treatment - superficial							
	Superficial/orthovoltage radiotherapy room	30.0	1	30.0				It is recommended that this room is sized as an orthovoltage room; otherwise 21 sqm is required
	Control area serving superficial/orthovoltage treatment room	12.0	1	12.0				
	Machine room							The generator can be located in the control room
	HDR brachytherapy							
J1255	Waiting area: 6 places	2.25	6	13.5				Includes children's play area and 10% wheelchair places. With trolley wait, depending on local practice
J1264	Parking bay: trolley/bed	4.0	2	8.0				
T0535	Clean utility room	16.0	1	16.0				
Y0436	Dirty utility room	12.0	1	12.0				Based on a theatre dirty utility
V0922	WC: independent wheelchair	4.5	1	4.5				
	Brachytherapy treatment room and maze	68.0	1	68.0				
	Control area serving brachytherapy treatment room	12.0	1	12.0				
B2532	Recovery room: 2 patient	28.0	1	28.0				
	Sealed source							
W0610	Store: sealed radioactive source	6.0	1	6.0				
T0529	Prep area: sealed radioactive source	12.0	1	12.0				This space may be required to provide for local operational procedures where the sealed source is prepared in an isolator
	Radiotherapy physics and technology							
	Mechanical workshop and machine room	50.0	1	50.0				
	Dosimetry laboratory	28.0	1	28.0				
	Offices for radiation protection, research and imaging physicists		1					Quantum of provision to be determined locally
	Staff support							
V0554-03	Changing area: staff (size based on number of lockers)	1.4	33	46.2				Includes uniform exchange area, showers and a number of individual changing rooms. Based on 30 staff who need a locker (allowing for shift changeover), plus a 10% contingency to allow for male/female split (suggested apportionment 2/3 female to 1/3 male)
V0725	Changing room: semi-ambulant	2.0	1	2.0				Additional individual changing room to allow for male and female
V1321	Shower room: ambulant	2.5	1	2.5				Additional shower room to allow for male and female segregation
V1010	WC: ambulant	2.0	2	4.0				
	Radiotherapy (PDR brachytherapy) facilities							
X2062	Radiotherapy treatment room: PDR brachytherapy	29.5	1	29.5				Size includes thickness of concrete walls
V1631-01	Shower, WC and wash: radiation-protective	5.5	1	5.5				
	Radiotherapy (unsealed source) facilities							
	Radiotherapy treatment room: unsealed radioactive sorce	29.5	1	29.5				Size includes thickness of concrete walls
	Lobby	5.5	1	5.5				
	Shower, WC and wash: radiation-protective	5.5	1	5.5				
Y0661	Hold: disposal, radioactive waste	2.0	1	2.0				
Relationship of schedule to ADB room names								
Relationship of schedule to ADB for scalable rooms (ie those for which a recommended room size does not exist)								
Optional accommodation								
Circulation, communication and engineering services allowances								

15 References

General sources

Macmillan Quality Environment Mark (MQEM).

Improving outcomes: a strategy for cancer (DH, January 2011)

Manual for cancer services: Various documents (DH)

Improving outcomes in children and young people with cancer (NICE, 2005)

Improving outcomes in children and young people with cancer: Guidance on commissioning services for young people (DH, 2008)

King's Fund, 'Improving environments for care at end of life'.

Chemotherapy sources

Response to consultation: Revised chemotherapy measures for the Manual for cancer services (DH, 2011)

Chemotherapy services: Ensuring quality and safety (DH, 2010)

HSC 2008/001 Updated national guidance on the safe administration of intrathecal chemotherapy (DH)

Chemotherapy services in the community (DH, 2010)

Radiotherapy sources

Developing a world class service for England (National Radiotherapy Advisory Group, 2007)

Equipment, workload and staffing for radiotherapy in the UK 1997–2002 (Royal College of Radiotherapists, 2003)

Making your radiotherapy service more patient-friendly (RCR, 2007)

The role and development of brachytherapy services in the United Kingdom (RCR, 2007)

Guidance on the development and management of devolved radiotherapy services (RCR, 2004)

Department of Health

Health Building Note 00-01 – General design principles.

Health Building Note 6 Vol 1 – Facilities for diagnostic imaging and interventional radiology.

Health Building Note 15 – Facilities for pathology services.

Health Building Note 26 Volume 1 – Facilities for surgical procedures.

Health Building Note 10-02 – Day surgery facilities.

Health Building Note 57 – Facilities for critical care.

Health Building Note 14-01 – Medicines management: Pharmacy and radiopharmacy facilities.

Health Building Note 00-04 – Circulation and communication spaces.

Health Building Note 00-02 – Sanitary spaces.

Health Building Note 00-03 – Clinical and clinical support spaces.

Health Technical Memorandum 03-01 – Specialised ventilation for healthcare premises.

Legislation and other

Radioactive Substances Act 1993.

Ionising Radiations Regulations 1999.

'Working with ionising radiation' (HSE).

Ionising Radiation (Medical Exposure) Regulations 2000.

High-activity Sealed Radioactive Sources and Orphan Sources Regulations 2005 (the 'HASS Regulations').

DB 2008(03) 'Guidance on the safe use of lasers, IPL systems and LEDs'.

BS 7671:2008 'Requirements for electrical installations. IEE Wiring Regulations'.

Guidance Note 7 'Special Locations'. Institution of Engineering and Technology (IET).

BS EN 60601-1-2 'Medical electrical equipment. Particular requirements for the basic safety and essential performance of high frequency surgical equipment and high frequency surgical accessories'.

Technical Handbook - Non-Domestic

Technical Handbook - Non-Domestic

Table of Contents

3.14 Ventilation

Mandatory Standard

Standard 3.14

Every building must be designed and constructed in such a way that ventilation is provided so that the air quality inside the building is not a threat to the building or the health of the occupants.

3.14.0 Introduction

Ventilation of a building is required to maintain air quality and so contribute to the health and comfort of the occupants. Without ventilation it is possible that carbon dioxide, water vapour, organic impurities, smoking, fumes and gases could reduce the air quality by humidity, dust and odours and also reduce the percentage of oxygen in the air to make the building less comfortable to work or live in.

Well designed natural ventilation has many benefits, not least financial and environmental, although it is also recognised that inside air quality can only be as good as outside air quality and in some cases filtration may be necessary. In other cases mechanical systems or systems that combine natural with mechanical (hybrid) may provide the ventilation solution for the building.

Ventilation can also have a significant affect on energy consumption and performance and so thorough assessment of natural, as against mechanical ventilation, should be made, as the decision could significantly affect the energy efficiency of the building (see Section 6, Energy).

Ventilation should not adversely affect comfort and, where necessary, designers might wish to consider security issues and protection against rain penetration prevalent in naturally ventilated buildings when windows are partially open to provide background ventilation.

Reducing air infiltration - improved insulation and ‘tighter’ construction of buildings will reduce the number of natural air changes but can increase the risk of condensation. However leaky buildings are draughty and uncomfortable. Sealing up air leaks improves comfort and saves energy whilst proper ventilation keeps the indoor air pleasant and healthy. If poor attention to detail occurs air leakage can account for a substantial part of the heating costs. Energy savings from building ‘tighter’ could make significant savings on energy bills. There is a common perception that ‘tight’ construction promotes indoor air pollution. However both ‘tight’ and 'leaky' buildings can have air quality problems. Though air leaks can dilute indoor pollutants, there is no control over how much leakage occurs, when it occurs or where it comes from. BRE GBG 67, ‘Achieving air tightness: General principles’ provides useful guidance on how to build new buildings tighter.

Conversions - in the case of conversions, as specified in regulation 4, the building as converted shall meet the requirement of this standard (regulation 12, schedule 6).

3.14.1 Ventilation generally

A building should have provision for ventilation by either:

a. natural means, or

b. mechanical means, or

c. a combination of natural and mechanical means (mixed-mode).

Ventilation is the process of supplying outdoor air to an enclosed space and removing stale air from the space. It can manage the indoor air quality by both diluting the indoor air with less contaminated outdoor air and removing the indoor contaminants with the exhaust air. Ventilation should have the capacity to:

- provide outside air to maintain indoor air quality sufficient for human respiration
- remove excess water vapour from areas where it is produced in sufficient quantities in order to reduce the likelihood of creating conditions that support the germination and growth of mould, harmful bacteria, pathogens and allergies
- remove pollutants that are a hazard to health from areas where they are produced in significant quantities
- rapidly dilute pollutant odours, where necessary.

Additional ventilation provision - this guidance relates to the provision of air for human respiration and is in addition to, and should be kept separate from, any air supply needed for the smoke ventilation of escape routes in the case of fire (Section 2, Fire) and for the safe operation of combustion appliances (see Standards 3.21 and 3.22).

There is no need to ventilate:

a. a store room used only for storage that requires a controlled temperature

b. a room with a floor area of not more than $4m^2$. This is not intended to include a domestic sized kitchen or utility room where ventilation should be in accordance with the recommendations in the table in clause 3.14.5.

Ventilation should be to the outside air. However clause 3.14.3 explains where trickle ventilators may be installed other than to the external air.

Calculation of volume - for ventilation purposes, a storey should be taken as the total floor area of all floors within that storey, including the floor area of any gallery or openwork floor. Where an air change rate is recommended, the volume of the space to be ventilated may be required. The volume of any space is the internal cubic capacity of the space. Any volume more than 3m above any floor level in that space may be disregarded.

3.14.2 Natural ventilation

All buildings leak air to a greater or lesser extent. However the movement of uncontrolled infiltrating air through the fabric of a building can cause draughts and can have a significant adverse effect on the energy efficiency of the building as a whole. By improving building techniques it is possible to reduce this infiltrating air to lower levels that can improve energy efficiency (see Section 6 Energy).

Some building techniques may have little effect on air leakage and so allow the uncontrolled infiltrating air to be taken into account in the building's ventilation provision. By building with techniques designed to reduce air leakage there will need to be a reciprocal increase in the designed ventilation provision to make up for the lower levels of infiltrating air where the designer intends to use low fabric insulation rates of less than $5m^3/h/m^2$ in the energy assessment (see Section 6 Energy). The areas of trickle ventilation shown may not suffice to maintain air quality and therefore an alternative ventilation solution should be adopted.

Natural ventilation of a room or building should be provided in accordance with the following recommendations:

a. for a room, by the provision of a ventilator with an opening area of at least 1/30th of the floor area of the room it serves, and

- a trickle ventilator with an opening area of at least 4000mm^2, if the area of the room is not more than 10m^2, or
- a trickle ventilator with an opening area of 400mm^2 for each square metre of room area, if the area of the room is more than 10m^2, or

b. for a room in a building constructed with an infiltration rate of 5 to 10m^3/h/m^2 at 50 Pa, by the provision of a ventilator with an opening area of at least 1/30th of the floor area of the room it serves, and

- a trickle ventilator with an opening of at least 10000mm^2 if the room is not more than 10m^2, or
- a trickle ventilator with an opening area of at least 10000mm^2 plus an additional 600mm^2 for each square metre of room area if the room is more than 10m^2

c. for a toilet, mechanical extract in accordance with the table to clause 3.14.5

d. for any other building, by following the guidance in:

- Section 3 of BS 5925: 1991 (1995), or
- CIBSE Guide A: 1999, Design data, section A4, Air infiltration and natural ventilation, or
- CIBSE AM10: Natural Ventilation in Non-Domestic Buildings (2005) Applications Manual AM10: 2005.

The options in sub-clause (d) provide more flexible solutions but may require complex calculations.

Wet areas - where a building is naturally ventilated, all moisture producing areas such, as bathrooms and shower rooms, should have the additional facility for removing such moisture before it can damage the building. Additional mechanical ventilation to such areas should be provided in accordance with the table to clause 3.14.5.

Opening height - where rapid ventilation is provided, such as an opening window or windows, some part of the opening should be at least 1.75m above floor level. This will reduce the problems of stratification of air.

3.14.3 Trickle ventilators

A trickle ventilator, sometimes called 'background ventilation', is a small ventilation opening, mostly provided in the head of a window frame, but not always, and is normally provided with a controllable shutter. They should be provided in naturally ventilated areas to allow fine control of air movement. A permanent ventilator is not recommended since occupants like control over their environment and uncontrollable ventilators are usually permanently sealed to prevent draughts.

The trickle ventilator should be so positioned that a part of it is at least 1.75m above floor level. This will allow at least some movement of air within the building and reduce stratification.

Although ventilation should normally be to the external air, a trickle ventilator serving a bathroom or shower room may open into an area that does not generate moisture, such as a bedroom or hallway, provided the room is fitted with a trickle ventilator in accordance with the guidance in clause 3.14.2.

A trickle ventilator should be provided in an area containing mechanical extraction to provide replacement air and ensure efficient operation when doors are closed. This will

prevent moist air being pulled from other ‘wet areas’. Pulling moist air from other parts of a building will reduce the further apart the wet rooms are located. The trickle ventilator should be independent of the mechanical extract so that replacement air can be provided when the extract fan is operating. The location of the trickle ventilator and the extract fan should be located to prevent short-circuiting of the air.

3.14.4 Extensions built over existing windows

Constructing an extension over an existing window, or ventilators, will effectively result in an internal room, will restrict air movement and could significantly reduce natural ventilation to that room. Reference should be made to the guidance to Standards 3.21 and 3.22 on the ventilation of combustion appliances, as this may be relevant. There are other recommendations in Section 2: Fire, relating to escape from inner rooms.

A new ventilator and trickle ventilator should be provided to the existing room but, where this is not reasonably practicable, e.g. if virtually the entire external wall of the room is covered by the extension, the new extension should be treated as part of the existing room rather than the creation of a separate internal room. Because an extension will be relatively airtight, the opening area between the 2 parts of the room should be not less than 1/15th of the total combined area of the existing room plus the extension.

If the extension is constructed over an area that generates moisture, such as a kitchen, bathroom, shower room or utility room, mechanical extract, via a duct if necessary, should be provided direct to the outside air. Any existing system disadvantaged by the work may require to be altered to ensure supply and extracted air are still to the outside air.

3.14.5 Mechanical ventilation

A mechanical ventilation or air conditioning system should be designed, installed and commissioned to perform in a way that is not be detrimental to the health of the occupants of a building and when necessary should be easily accessible for regular maintenance.

Mechanical extract should be provided in rooms where the cubic space per occupant is not more than $3m^3$, and where the rooms have low ceilings and are occupied by large numbers of people.

Mechanical ventilation should be provided in accordance with the following:

a. compliance with guidance in BS 5720: 1979, or

b. compliance with the guidance in CIBSE Guide B: 2001, Installation and equipment data, section B2, Ventilation and air-conditioning (requirements), or

c. for occupiable rooms, where a mechanical air supply is provided at a rate of at least 8 litres/second of fresh air per occupant, based on sedentary occupants and the absence of other requirements such as the removal of moisture, or

d. for domestic-sized rooms where moisture is produced, such as kitchens, bathrooms and sanitary accommodation, rapid ventilation and trickle ventilation should be provided in accordance with the guidance in the following table.

Table 3.9 Mechanical ventilation of domestic-sized kitchens, bathrooms & toilets

Space	Ventilation provision [2]	Trickle ventilation >10 $m^3/h/m^2$	Trickle ventilation 5-10 $m^3/h/m^2$
Kitchen	either: a. mechanical extraction	$4000mm^2$	$10000mm^2$

Space	Ventilation provision [2]	Trickle ventilation >10 $m^3/h/m^2$	Trickle ventilation 5-10 $m^3/h/m^2$
	capable of at least 30 litres/ sec (intermittent) above a hob [2]; or b. mechanical extraction capable of at least 60 litres/sec (intermittent) if elsewhere [3]		
Utility room or washroom	mechanical extraction capable of at least 30 litres/sec (intermittent) [3]	4000mm^2	10000mm^2
Bathroom or shower room (with or without a WC)	mechanical extraction capable of at least 15 litres/sec (intermittent)	4000mm^2	10000mm^2
Toilet	mechanical extraction capable of at least 3 air changes per hour	4000mm^2	10000mm^2

Additional information:

1. The trickle ventilation rates recommended relate to the infiltration rate of the building fabric which can be used in SBEM calculations (see Section 6 Energy).

2. Where the building infiltration rate is designed to be less than 5$m^3/h/m^2$ the trickle vent rates in the above table might not be sufficient to maintain air quality and an alternative solution should be adopted.

3. Long duct runs, flexible ducting and bends can seriously reduce fan performance and should be carefully considered during design to ensure recommended air flows are achieved.

4. Refer to guidance to Standard 3.17 and OFTEC Technical Book 3 where an extract fan is fitted in a building containing an open-flued combustion appliance. Extract rates should be reduced.

Continuous mechanical ventilation - for smaller, domestic sized developments, a mechanical ventilation system complying with BRE Digest 398, ‘Continuous mechanical ventilation in dwellings: design, installation and operation’ may be appropriate.

Where a mechanical ventilation system gathers extracts into a common duct for discharge to an outlet, no connection to the system should be made between any exhaust fan and the outlet.

Mechanical ventilation should be to the outside air. However it may be via a duct or heat exchanger.

Care should be taken when installing mechanical extract systems where there is an open-flued combustion appliance in the same room or close by. Guidance is given in clause 3.17.8, extract fans.

Cross contamination - an inlet to, and an outlet from, a mechanical ventilation system should be installed so as to avoid contamination of the air supply to the system. The inlet to, and the outlet from, the mechanical ventilation system should be installed in accordance with the recommendations in clause 2.3.3 of BS 5720: 1979.

3.14.6 Control of legionellosis

A mechanical ventilation system should be constructed to ensure, as far as is reasonably practicable, the avoidance of contamination by legionella. The ventilation system should be constructed in accordance with the recommendations of Legionnaires' Disease: The control of legionella bacteria in water systems - approved code of practice and guidance - HSE L8.

The guidance provided in HSE catering sheet No 10, 2000: 'Ventilation of kitchens in catering establishments' provides useful information.

There are additional recommendations in Section 2, Fire where mechanical ventilation systems pass through compartment walls, separating walls and separating floors.

3.14.7 Ventilation of sanitary accommodation

Any area containing sanitary facilities should be well ventilated, so that offensive odours do not linger. Measures should be taken to prevent odours entering other rooms. This may be achieved by, for example, providing a ventilated area between the sanitary accommodation and the other room. Alternatively it may be possible to achieve it by mechanical ventilation or, if the sanitary accommodation is well sealed from a workroom and has a door with an automatic closer, by good natural ventilation.

However no room containing sanitary facilities should communicate directly with a room for the preparation or consumption of food. This does not apply to places of lawful detention, such as integral sanitation in prison cells.

3.14.8 Ventilation of small garages

The principal reason for ventilating garages is to protect the building users from the harmful effects of toxic emissions from vehicle exhausts. Where a garage is attached to a building, designers may wish to consider making the separating construction as air tight as possible. Where there is a communicating door, a lobby arrangement could be considered.

Garages of less than $30m^2$ do not require the ventilation to be designed. It is expected that a degree of fortuitous ventilation is created by the imperfect fit of 'up and over' doors or pass doors. With such garages, it is inadvisable for designers to attempt to achieve an airtight construction.

A garage with a floor area of at least $30m^2$ but not more than $60m^2$ used for the parking of motor vehicles should have provision for natural or mechanical ventilation. Ventilation should be in accordance with the following guidance:

a. where the garage is naturally ventilated, by providing at least 2 permanent ventilators, each with an open area of at least 1/3000th of the floor area they serve, positioned to encourage through ventilation with one of the permanent ventilators being not more than 600mm above floor level, or

b. where the garage is mechanically ventilated, by providing a system:

   - capable of continuous operation, designed to provide at least 2 air changes per hour, and

   - independent of any other ventilation system, and

- constructed so that two-thirds of the exhaust air is extracted from outlets not more than 600mm above floor level.

3.14.9 Ventilation of large garages

A garage with a floor area more than 60m^2 for the parking of motor vehicles should have provision for natural or mechanical ventilation on every storey. Ventilation should be in accordance with the following guidance:

a. Section 3 requirements of CIBSE Guide B2: 2001, Ventilation and air conditioning:

   - to give carbon monoxide concentrations of not more than 30 parts per million averaged over an 8 hour period, and
   - to restrict peak concentrations of carbon monoxide at areas of traffic concentrations such as ramps and exits to not more than 90 parts per million for periods not exceeding 15 minutes, or

b. Section 4 of the Association for Petroleum and Explosive Administration's "Code of practice for ground floor, multi-storey and underground car parks" and CIBSE Guide B, 1986, Section B2, or

c. By providing openings in the walls on every storey of at least 1/20th of the floor area of that storey with at least half of such area in opposite walls to promote extract ventilation, if the garage is naturally ventilated, or

d. By providing mechanical ventilation system capable of at least 6 air changes per hour and at least 10 air changes per hour where traffic concentrations occur, or

e. Where it is a combined natural/mechanical ventilation system, by providing:

   - openings in the wall on every storey of at least 1/40th of the floor area of the storey with at least half of such area in opposite walls, and
   - a mechanical system capable of at least 3 air changes per hour.

3.15 Condensation

Mandatory Standard

Standard 3.15

Every building must be designed and constructed in such a way that there will not be a threat to the building or the health of the occupants as a result of moisture caused by surface or interstitial condensation.

3.15.0 Introduction

Condensation can occur in heated buildings when water vapour, usually produced by the occupants and their activities, condenses on exposed building surfaces (surface condensation) where it supports mould growth, or within building elements (interstitial condensation).

The occurrence of condensation is governed by complex interrelationships between heating, ventilation, moisture production, building layout and properties of materials. Condensation need not always be a problem, for example it regularly occurs on the inner

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NICE guideline

Tuberculosis

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Your responsibility

The recommendations in this guideline represent the view of NICE, arrived at after careful consideration of the evidence available. When exercising their judgement, professionals and practitioners are expected to take this guideline fully into account, alongside the individual needs, preferences and values of their patients or the people using their service. It is not mandatory to apply the recommendations, and the guideline does not override the responsibility to make decisions appropriate to the circumstances of the individual, in consultation with them and their families and carers or guardian.

All problems (adverse events) related to a medicine or medical device used for treatment or in a procedure should be reported to the Medicines and Healthcare products Regulatory Agency using the Yellow Card Scheme.

Local commissioners and providers of healthcare have a responsibility to enable the guideline to be applied when individual professionals and people using services wish to use it. They should do so in the context of local and national priorities for funding and developing services, and in light of their duties to have due regard to the need to eliminate unlawful discrimination, to advance equality of opportunity and to reduce health inequalities. Nothing in this guideline should be interpreted in a way that would be inconsistent with complying with those duties.

Commissioners and providers have a responsibility to promote an environmentally sustainable health and care system and should assess and reduce the environmental impact of implementing NICE recommendations wherever possible.

Contents

This guideline replaces CG117 and PH37.

This guideline is the basis of QS141.

Overview

This guideline covers preventing, identifying and managing latent and active tuberculosis (TB) in children, young people and adults. It aims to improve ways of finding people who have TB in the community and recommends that everyone under 65 with latent TB should be treated. It describes how TB services should be organised, including the role of the TB control board.

Who is it for?

- Healthcare professionals and TB multidisciplinary teams
- Substance misuse services, prisons and immigration removal centres
- Local government and commissioners
- TB control boards, directors of public health and public health consultants
- Public Health England and NHS England
- Voluntary sector workers
- People with TB and their carers

Recommendations

People have the right to be involved in discussions and make informed decisions about their care, as described in making decisions about your care.

Making decisions using NICE guidelines explains how we use words to show the strength (or certainty) of our recommendations, and has information about prescribing medicines (including off-label use), professional guidelines, standards and laws (including on consent and mental capacity), and safeguarding.

1.1 Preventing TB

1.1.1 Raising and sustaining awareness of TB

Among health professionals and those working with high-risk groups

1.1.1.1 Multidisciplinary TB teams (in collaboration with Public Health England, primary care, the voluntary sector and Health Education England) should identify and support an ongoing TB education programme for local professionals in contact with the general public, and at-risk groups in particular. This includes, for example, staff in emergency departments, GPs and wider primary care staff, people who work in housing support services, staff who support migrants and those working in walk-in centres, hostels, substance misuse projects and prisons. **[2012, amended 2016]**

1.1.1.2 Multidisciplinary TB teams should ensure the education programme increases other professionals' awareness of the possibility of TB and reduces the stigma associated with it. The programme should include detail on:

- causes of TB, how it is transmitted, and the signs and symptoms
- lifestyle factors that may mask symptoms
- local epidemiology, highlighting under-served groups, other high-risk groups

and the fact that TB also occurs in people without risk factors

- principles of TB control:
  - early diagnosis and active case-finding
  - how to support treatment (including directly observed therapy)
  - drug resistance
  - awareness of drug interactions (including factors such as effect on contraception efficacy)
  - contact investigation after diagnosing an active case
  - the importance of adhering to treatment
  - treatment for TB is free for everyone (irrespective of eligibility for other NHS care)
  - social and cultural barriers to accessing health services (for example, fear of stigma and staff attitudes)
  - local referral pathways, including details of who to refer and how
  - the role of allied professionals in awareness-raising, identifying cases and helping people complete treatment
  - misinformation that causes fear about TB, including concerns about housing people with the condition
- the best ways to effectively communicate all the above topics with different groups. **[2012, amended 2016]**

1.1.1.3 Statutory, community and voluntary organisations and advocates working with the general public, and under-served and high-risk groups in particular, should share information on TB education and awareness training with all frontline staff. (They should get information on this from the local multidisciplinary TB team.) **[2012, amended 2016]**

1.1.1.4 If possible, statutory, community and voluntary organisations should ensure

peers from under-served groups and anyone else with experience of TB contribute to, or lead, awareness-raising activities. (Peers who lead such activities will need training and support.) **[2012, amended 2016]**

Among high-risk groups

1.1.1.5 Multidisciplinary TB teams should help professionals working in relevant statutory, community and voluntary organisations to raise awareness of TB among under-served and other high-risk groups. These professionals should be able to explain that treatment for TB is free and confidential for everyone (irrespective of eligibility for other NHS care). They should also be able to provide people with details of:

- how to recognise symptoms in adults and children
- how people get TB
- the benefits of diagnosis and treatment (including the fact that TB is treatable and curable)
- location and opening hours of testing services
- referral pathways, including self-referral
- the potential interaction of TB medication with other drugs, for example, oral contraceptives and opioids (especially methadone) and HIV treatment
- TB/HIV co-infection
- how to address the myths about TB infection and treatment (for example, to counter the belief that TB is hereditary)
- how to address the stigma associated with TB
- the risk of migrants from high-incidence countries developing active TB, even if they have already screened negative for it
- contact tracing. **[2012, amended 2016]**

1.1.1.6 Multidisciplinary TB teams and others working with at-risk groups should use

high quality material to raise awareness of TB (see section 1.1.2). **[2012, amended 2016]**

1.1.1.7 Multidisciplinary TB teams and others working with the general public, and with under-served and other high-risk groups in particular, should include information on TB with other health-related messages and existing health promotion programmes tailored to the target group. **[2012, amended 2016]**

1.1.1.8 Multidisciplinary TB teams should work in partnership with voluntary organisations and 'community champions' to increase awareness of TB, in particular among under-served groups at risk of infection but also in the general population. If possible, peers who have experience of TB should contribute to awareness-raising activities and support people in treatment. **[2012, amended 2016]**

1.1.2 Providing information for the public about TB

1.1.2.1 National organisations (for example, National Knowledge Service: Tuberculosis, TB Alert, Public Health England, Department of Health and NHS Choices) should work together to develop generic, quality-assured template materials with consistent up-to-date messages. These materials should be made freely available and designed so that they can be adapted to local needs. **[new 2016]**

1.1.2.2 Multidisciplinary TB teams should use these templates for general awareness raising and targeted activities in under-served and other high-risk groups. Involve the target group in developing and piloting the materials. **[new 2016]**

1.1.2.3 The content of any materials should:

- be up-to-date and attractively designed, including pictures and colour if possible
- be culturally appropriate, taking into account the language, actions, customs, beliefs and values of the group they are aimed at
- be tailored to the target population's needs

- include risks and benefits of treatment, and how to access services, advice and support
- dispel myths
- show that, by deciding to be tested and treated for TB, a person can be empowered to take responsibility for their own health
- use language that encourages the person to believe that they can change their behaviour
- be simple and succinct. **[new 2016]**

1.1.2.4 Make the material available in a range of formats such as written, braille, text messages, electronic, audio (including podcasts), pictorial and video. Make them freely available in a variety of ways, for example, online, as print materials or on memory sticks. **[new 2016]**

1.1.2.5 Disseminate materials in ways likely to reach target groups, for example, via culturally specific radio or TV stations, at shelters, and at community, commercial or religious venues that target groups attend regularly. **[new 2016]**

1.1.3 BCG vaccination

1.1.3.1 To improve the uptake of BCG vaccination, identify eligible groups (in line with the Department of Health's Green Book) opportunistically through several routes, for example:

- new registrations in primary care and with antenatal services, or other points of contact with secondary or tertiary care
- people entering education, including university
- links with statutory and voluntary groups working with new entrants and looked-after children and young people
- during contact investigations. **[new 2016]**

1.1.3.2 When BCG vaccination is being recommended, discuss the benefits and risks of vaccination or remaining unvaccinated with the person (or, if a child, with the parents), so that they can make an informed decision. Tailor this discussion to the person, use appropriate language, and take into account cultural sensitivities and stigma. **[2006]**

1.1.3.3 If people identified for BCG vaccination through occupational health, contact tracing or new entrant screening are also considered to be at increased risk of being HIV-positive, offer them HIV testing before BCG vaccination. **[2006]**

BCG vaccination in neonates (0 to 4 weeks)

1.1.3.4 Identify babies eligible for vaccination (in line with the Green Book) before birth, ideally through antenatal services. **[new 2016]**

1.1.3.5 Discuss neonatal BCG vaccination for any baby at increased risk of TB with the parents or legal guardian. **[2006]**

1.1.3.6 Preferably vaccinate babies at increased risk of TB before discharge from hospital or before handover from midwifery to primary care. Otherwise, vaccinate as soon as possible afterwards, for example, at the 6-week postnatal check. **[new 2016]**

1.1.3.7 Incorporate computer reminders into maternity service (obstetrics) IT systems for staff, to identify and offer BCG vaccination to babies eligible for vaccination. **[new 2016]**

1.1.3.8 Provide education and training for postnatal ward staff, midwives, health visitors and other clinicians on identifying babies eligible for vaccination, local service information and providing BCG vaccination, including:

- case definition for at-risk groups to be offered vaccination
- information about the local BCG vaccination policy that can be given verbally, in writing or in any other appropriate format (see sections 1.1.1 and 1.1.2) to parents and carers at the routine examination of the baby before discharge

- local service information about BCG vaccination, such as pre-discharge availability of neonatal vaccination, local BCG clinics and referral for BCG vaccination if this is not available in maternity services
- administration of BCG vaccination and contraindications. **[new 2016]**

1.1.3.9 Primary care organisations with a high incidence of TB should consider vaccinating all neonates soon after birth. **[2006]**

1.1.3.10 In areas with a low incidence of TB (see Public Health England's TB rate bands, published in their annual tuberculosis report), primary care organisations should offer BCG vaccination to selected neonates who:

- were born in an area with a high incidence of TB **or**
- have 1 or more parents or grandparents who were born in a high-incidence country. **[2006, amended 2024]**

BCG vaccination for infants (0 to 5 years) and older children (6 to 15 years)

1.1.3.11 Routine BCG vaccination is not recommended for children aged 10 to 14 years.

- Healthcare professionals should opportunistically identify unvaccinated children older than 4 weeks and younger than 16 years at increased risk of TB who would have qualified for neonatal BCG (see recommendation 1.1.3.4) and provide Mantoux testing (see the section on diagnosing latent TB in children and young people) and BCG vaccination (if Mantoux-negative).

  At the time of publication (January 2016) the BNF states: 'The Mantoux test is recommended for tuberculin skin testing, but no licensed preparation is currently available.' For further guidance, see immunisation against infectious disease (the Green book).

- This opportunistic vaccination should be in line with the Green Book. **[2006, amended 2016]**

1.1.3.12 Mantoux testing should not be done routinely before BCG vaccination in children

younger than 6 years unless they have a history of residence or prolonged stay (more than 1 month) in a country with a high incidence of TB. **[2006]**

BCG vaccination for new entrants from high-incidence areas

1.1.3.13 Offer BCG vaccination to new entrants who are Mantoux-negative who:

- are from high-incidence countries **and**
- are previously unvaccinated (that is, without adequate documentation or a BCG scar) **and**
- are aged:
  - younger than 16 years **or**
- 16 to 35 years from sub-Saharan Africa or a country with a TB incidence of 500 per 100,000 or more. **[2006, amended 2016]**

Encouraging uptake among infants, older children and new entrants

1.1.3.14 Deliver the following interventions in primary care settings to improve uptake of BCG vaccination in people from eligible groups (as outlined in the Green Book):

- education and support for practice staff, including:
  - raising awareness of relevant guidelines and case definition for at-risk groups
  - promoting BCG and TB testing in eligible groups
- incorporating reminders for staff (prompts about eligibility for BCG) on practice computers (for example, embedded in medical records)
- consider financial incentives for practices for identifying eligible groups for BCG and TB testing
- reminders ('immunisations due') and recall ('immunisations overdue') for people who are eligible for vaccination or for parents of infants and children

who are eligible, as outlined in the Green Book. (This could include written reminders, telephone calls from a member of staff or a computerised auto dialler, text messages or a combination of these approaches.) **[new 2016]**

1.1.3.15 Use home visits to give information and advice to people who are disadvantaged on the importance of immunisation. This should be delivered by trained lay health workers, community-based healthcare staff or nurses. **[new 2016]**

BCG vaccination for healthcare workers

1.1.3.16 Offer BCG vaccination to healthcare workers and other NHS employees as advised in the Green Book. **[2006, amended 2016]**

BCG vaccination for contacts of people with active TB

1.1.3.17 Offer BCG vaccination to Mantoux-negative contacts of people with pulmonary and laryngeal TB (see the section on diagnosing latent TB in all age groups) if they:

- have not been vaccinated previously (that is, there is no adequate documentation or a BCG scar) **and**
- are aged 35 years or younger **or**
- are aged 36 years and older and a healthcare or laboratory worker who has contact with patients or clinical materials. **[2006, amended 2016]**

BCG vaccination for other groups

1.1.3.18 Offer BCG vaccination to previously unvaccinated, Mantoux-negative people aged 35 years or younger in the following groups at increased risk of exposure to TB, in accordance with the Green Book:

- veterinary and other staff such as abattoir workers who handle animal species known to be susceptible to TB, such as simians

- prison staff working directly with prisoners
- staff of care homes for older people
- staff of hostels for people who are homeless and facilities accommodating refugees and asylum seekers
- people going to live or work with local people for more than 3 months in a high-incidence country. **[2006, amended 2016]**

1.1.4 Preventing infection in specific settings

Healthcare environments: new NHS employees

1.1.4.1 Employees new to the NHS who will be working with patients or clinical specimens should not start work until they have completed a TB screen or health check, or documentary evidence is provided of such screening having taken place within the preceding 12 months. **[2006]**

1.1.4.2 Employees new to the NHS who will not have contact with patients or clinical specimens should not start work if they have signs or symptoms of TB. **[2006]**

1.1.4.3 Health checks for employees new to the NHS who will have contact with patients or clinical materials should include:

- assessment of personal or family history of TB
- asking about symptoms and signs, possibly by questionnaire
- documentary evidence of TB skin (or interferon-gamma release assay) testing within the past 5 years and/or BCG scar check by an occupational health professional, not relying on the applicant's personal assessment. **[2006]**

1.1.4.4 See the section on healthcare workers for screening new NHS employees for latent TB. **[2006, amended 2011]**

1.1.4.5 Employees who will be working with patients or clinical specimens and who are Mantoux- or interferon-gamma release assay-negative (see section 1.2.1) should have an individual risk assessment for HIV infection before BCG vaccination is given. **[2006, amended 2016]**

1.1.4.6 Offer BCG vaccination to employees of any age who are new to the NHS and are from countries of high TB incidence, or who have had contact with patients in settings with a high TB prevalence, and who are Mantoux-negative. **[2006, amended 2011]**

1.1.4.7 If a new employee from the UK or other low-incidence setting, who has not had a BCG vaccination, has a positive Mantoux test and a positive interferon-gamma release assay, they should have a medical assessment and a chest X-ray. They should be referred to a TB clinic to determine whether they need TB treatment if the chest X-ray is abnormal, or to determine whether they need treatment of latent TB infection if the chest X-ray is normal. **[2006, amended 2011, amended 2016]**

1.1.4.8 If a prospective or current healthcare worker who is Mantoux-negative (see the section on healthcare workers) declines BCG vaccination, explain the risks and supplement the oral explanation with written advice. If the person still declines BCG vaccination, he or she should not work where there is a risk of exposure to TB. The employer will need to consider each case individually, taking account of employment and health and safety obligations. **[2006, amended 2016]**

1.1.4.9 Screen clinical students, agency and locum staff and contract ancillary workers who have contact with patients or clinical materials for TB to the same standard as new employees in healthcare environments, according to the recommendations set out above. Seek documentary evidence of screening to this standard from locum agencies and contractors who carry out their own screening. **[2006]**

1.1.4.10 NHS trusts arranging care for NHS patients in non-NHS settings should ensure that healthcare workers who have contact with patients or clinical materials in these settings have been screened for TB to the same standard as new employees in NHS settings. **[2006]**

Healthcare environments: occupational health

1.1.4.11 Include reminders of the symptoms of TB, and the need for prompt reporting of such symptoms, with annual reminders about occupational health for staff who:

- are in regular contact with TB patients or clinical materials **or**
- have worked in a high-risk clinical setting for 4 weeks or longer.

Give one-off reminders after a TB incident on a ward. **[2006]**

1.1.4.12 If no documentary evidence of previous screening is available, screen staff in contact with patients or clinical material who are transferring jobs within the NHS as for new employees (see recommendations 1.2.1.5 to 1.2.1.7 in the section on healthcare workers). **[2006]**

1.1.4.13 Assess the risk of TB for a new healthcare worker who knows he or she is HIV-positive at the time of recruitment as part of the occupational health checks. **[2006]**

1.1.4.14 The employer, through the occupational health department, should be aware of the settings with increased risk of exposure to TB, and that these pose increased risks to HIV-positive healthcare workers. **[2006]**

1.1.4.15 Healthcare workers who are found to be HIV-positive during employment should have medical and occupational assessments of TB risk, and may need to modify their work to reduce exposure. **[2006]**

1.2 Latent TB

1.2.1 Diagnosing latent TB in adults

1.2.1.1 Offer Mantoux testing to diagnose latent TB in adults aged 18 to 65 who are close contacts of a person with pulmonary or laryngeal TB.

- If the Mantoux test is inconclusive, refer the person to a TB specialist.

- If the Mantoux test is positive (an induration of 5 mm or larger, regardless of BCG history) assess for active TB (see the sections on diagnosing active TB in all age groups, diagnosing pulmonary (including laryngeal) TB in all age groups, diagnosing pulmonary (including laryngeal) TB in adults and diagnosing extrapulmonary TB in all age groups).

- If the Mantoux test is positive but a diagnosis of active TB is excluded, consider an interferon gamma release assay if more evidence of infection is needed to decide on treatment. This could be, for example, if the person needs enhanced case management or if there could be adverse events from treatment.

- If the Mantoux is positive, and if an IGRA was done and that is also positive, offer them treatment for latent TB infection (see the sections on managing latent TB in all age groups and managing latent TB in adults).

  At the time of publication (January 2016) the BNF states: 'The Mantoux test is recommended for tuberculin skin testing, but no licensed preparation is currently available.' For further guidance, see immunisation against infectious disease (the Green book).**[2011, amended 2016]**

Adults who are immunocompromised

1.2.1.2 In adults who are anticipated to be or are currently immunocompromised, do a risk assessment to establish whether testing should be offered, taking into account their:

- risk of progression to active TB based on how severely they are immunocompromised and for how long they have been immunocompromised

- risk factors for TB infection, such as country of birth or recent contact with an index case with suspected infectious or confirmed pulmonary or laryngeal TB. **[new 2016]**

1.2.1.3 For adults who are severely immunocompromised, such as those with HIV and CD4 counts of fewer than 200 cells/mm^3, or after solid organ or allogeneic stem cell transplant, offer an interferon-gamma release assay and a concurrent

Mantoux test.

- If either test is positive (for Mantoux, this is an induration of 5 mm or larger, regardless of BCG history), assess for active TB.
- If this assessment is negative, offer them treatment for latent TB infection. **[new 2016]**

1.2.1.4 For other adults who are immunocompromised, consider an interferon-gamma release assay alone or an interferon-gamma release assay with a concurrent Mantoux test.

- If either test is positive (for Mantoux, this is an induration of 5 mm or larger, regardless of BCG history), assess for active TB.
- If this assessment is negative, offer them treatment for latent TB infection. **[new 2016]**

Healthcare workers

1.2.1.5 Offer a Mantoux test to new NHS employees who will be in contact with patients or clinical materials, if the employees:

- are not new entrants from high-incidence countries **and**
- have not had BCG vaccination (for example, they are without a BCG scar, other documentation or a reliable history).

  If the Mantoux test is positive, offer an interferon-gamma release assay. If this is positive, assess for active TB; if this assessment is negative, offer them treatment for latent TB infection. **[2011, amended 2016]**

1.2.1.6 Offer a Mantoux test to new NHS employees who are from a high-incidence country.

- If the Mantoux test is positive (5 mm or larger, regardless of BCG history), assess for active TB; if this assessment is negative, offer them treatment for latent TB infection.

- If Mantoux testing is unavailable, offer an interferon-gamma release assay. **[new 2016]**

1.2.1.7 Offer an interferon-gamma release assay to new NHS employees who have had contact with patients in settings where TB is highly prevalent:

- If the interferon-gamma release assay is positive, assess for active TB **and**
- if this assessment is negative, offer them treatment for latent TB infection. **[2011, amended 2016]**

1.2.1.8 Healthcare workers who are immunocompromised should be screened in the same way as other people who are immunocompromised (see recommendations 1.2.1.2 to 1.2.1.4). **[2011]**

1.2.2 Diagnosing latent TB in children and young people

1.2.2.1 Only consider using interferon-gamma release assays alone in children and young people if Mantoux testing is not available or is impractical. This includes for example, situations in which large numbers need to be tested (see the section on incident and outbreak response and recommendation 1.2.3.2). **[new 2016]**

1.2.2.2 Refer children younger than 2 years and in close contact with people with smear-negative pulmonary or laryngeal TB to a specialist to determine what testing strategy for latent TB should be done. This should be a paediatrician with experience and training in TB, or a general paediatrician with advice from a specialised clinician. **[new 2016]**

1.2.2.3 If a neonate has been in close contact with people with smear-positive pulmonary or laryngeal TB who have not had at least 2 weeks of anti-TB treatment:

- Assess for active TB (see the sections on diagnosing active TB in all age groups, diagnosing pulmonary (including laryngeal) TB in all age groups and diagnosing pulmonary (including laryngeal) TB in children and young people).
- Start isoniazid (with pyridoxine).

- Carry out a Mantoux test after 6 weeks of treatment.
- If the Mantoux test is inconclusive, refer the child to a TB specialist.
- If the Mantoux test is positive (5 mm or larger, regardless of BCG history), reassess for active TB; if this assessment is negative, continue isoniazid (with pyridoxine) for a total of 6 months.
- If the Mantoux test is negative, reassess for active TB and consider an interferon-gamma release assay:
  - if the interferon-gamma release assay is negative then stop isoniazid (and pyridoxine) and give a BCG vaccination
  - if the interferon-gamma release assay is positive, reassess for active TB; if this assessment for active TB is negative, continue isoniazid (with pyridoxine) for a total of 6 months. **[new 2016]**

1.2.2.4 If a child aged between 4 weeks and 2 years has been in close contact with people with smear-positive pulmonary or laryngeal TB who have not had at least 2 weeks of anti-TB treatment:

- Assess for active TB.
- Start treatment for latent TB (see the sections on managing latent TB in all age groups and managing latent TB in children and young people) and carry out a Mantoux test.
- If the Mantoux test is inconclusive, refer the child to a TB specialist.
- If the Mantoux test is positive (5 mm or larger, regardless of BCG history), reassess for active TB; if this assessment is negative, complete treatment for latent TB.
- If the Mantoux test is negative, continue treatment for latent TB, reassess for active TB after 6 weeks and repeat the Mantoux test:
  - if the Mantoux test is negative, consider an interferon-gamma release assay
  - if the interferon-gamma release assay is negative, treatment for latent TB

may be stopped; give a BCG vaccination if the child has not already had one

- if either test is positive, reassess for active TB; if this assessment is negative, complete treatment for latent TB. **[new 2016]**

1.2.2.5 If a child or young person aged between 2 and 17 years has been in close contact with people with pulmonary or laryngeal TB:

- Offer Mantoux testing.
- If the Mantoux test is inconclusive, refer the child or young person to a TB specialist.
- If the Mantoux test is positive (5 mm or larger, regardless of BCG history), assess for active TB; if this assessment is negative, offer them treatment for latent TB infection.
- If the initial Mantoux test is negative, offer an interferon-gamma release assay after 6 weeks and repeat the Mantoux test. **[new 2016]**

Immunocompromised children and young people

1.2.2.6 If latent TB is suspected in children and young people who are anticipated to be or are currently immunocompromised (for example, if they are from a high incidence country or have been in close contact with people with suspected infectious or confirmed pulmonary or laryngeal TB), refer to a TB specialist. **[2016]**

1.2.3 Diagnosing latent TB in all age groups

New entrants from high-incidence countries

1.2.3.1 Offer Mantoux testing as the initial diagnostic test for latent TB infection in people who have recently arrived from a high-incidence country who present to healthcare services. If the Mantoux test is positive (5 mm or larger, regardless of

BCG history):

- assess for active TB (see recommendations 1.3.1 to 1.3.5 in the section on active TB) **and**
- if this assessment is negative, offer them treatment for latent TB infection (see the section on managing latent TB in all age groups to the section on managing latent TB in children and young people).

  If Mantoux testing is unavailable, offer an interferon-gamma release assay. **[new 2016]**

Contacts: incident situation

1.2.3.2 In an incident situation when large numbers of people may need to be screened, consider a single interferon-gamma release assay for people aged 18 to 65 years. For children and young people, follow the recommendations in the sections on diagnosing latent TB in children and young people and immunocompromised children and young people. **[2011, amended 2016]**

Under-served groups

1.2.3.3 Offer people younger than 65 years from under-served groups a single interferon-gamma release assay. **[2011, amended 2016]**

1.2.3.4 Substance misuse services with access to an interferon-gamma release assay should provide testing for people younger than 65 years who misuse substances if they:

- live in a high incidence area
- are likely to be involved with substance misuse services or other support services on a regular basis (for example, for opioid substitution therapy), when support should be available for directly observed preventive therapy. **[2012, amended 2016]**

1.2.3.5 In high incidence areas (and at prisons that receive prisoners from high incidence

areas), prison health services should offer an interferon-gamma release assay for TB to inmates younger than 65 years who are in regular contact with substance misuse services or other support services. This is provided arrangements have been made for this support to continue after release. **[2012, amended 2016]**

1.2.3.6 Substance misuse services and prison health services should incorporate interferon-gamma release assay testing with screening for hepatitis B and C, and HIV testing. They should refer prisoners and people who misuse substances with positive interferon-gamma release assays to local multidisciplinary TB teams for further clinical investigations. For prisoners, these investigations should be done in the prison if practically possible. **[2012, amended 2016]**

1.2.3.7 If the interferon-gamma release assay is positive, assess for active TB (see the sections on diagnosing active TB in all age groups to diagnosing extrapulmonary TB in all age groups); if this assessment is negative, offer them treatment for latent TB infection (see sections on managing latent TB in all age groups to managing latent TB in children and young people). **[new 2016]**

1.2.4 Managing latent TB in all age groups

1.2.4.1 Be aware that certain groups of people with latent TB are at increased risk of going on to develop active TB, including people who:

- are HIV-positive
- are younger than 5 years
- have excessive alcohol intake
- are injecting drug users
- have had solid organ transplantation
- have a haematological malignancy
- are having chemotherapy
- have had a jejunoileal bypass

- have diabetes
- have chronic kidney disease or receive haemodialysis
- have had a gastrectomy
- are having treatment with anti-tumour necrosis factor-alpha or other biologic agents
- have silicosis. **[new 2016]**

1.2.4.2 For people, including those with HIV, aged younger than 65 years with evidence of latent TB who have been in close contact with people who have suspected infectious or confirmed active pulmonary or laryngeal drug-sensitive TB, offer either of the following drug treatments:

- 3 months of isoniazid (with pyridoxine) and rifampicin **or**
- 6 months of isoniazid (with pyridoxine). **[new 2016]**

1.2.4.3 Base the choice of regimen on the person's clinical circumstances. Offer:

- 3 months of isoniazid (with pyridoxine) and rifampicin to people younger than 35 years if hepatotoxicity is a concern after an assessment of both liver function (including transaminase levels) and risk factors
- 6 months of isoniazid (with pyridoxine) if interactions with rifamycins are a concern, for example, in people with HIV or who have had a transplant. **[new 2016]**

1.2.4.4 Clearly explain the risks and potential benefits of each treatment regimen. In discussion with the person, select a suitable regimen if they wish to proceed with preventive treatment. **[new 2016]**

1.2.4.5 If a person also has severe liver disease, for example, Child-Pugh level B or C, work with a specialist multidisciplinary team with experience of managing TB and liver disease. **[new 2016]**

1.2.4.6 Manage treatment with caution, ensuring careful monitoring of liver function, in:

- people with non-severe liver disease
- people with abnormal liver function (including abnormal transaminase levels) before starting treatment for latent TB infection
- people who misuse alcohol or drugs. **[new 2016]**

1.2.4.7 Ensure people having treatment for latent TB who also have social risk factors, such as misusing alcohol or drugs or being homeless, are linked to support services. They should also have an assessment of social needs and stability, including potential barriers to adherence or treatment completion (see the section on adherence, treatment completion and follow-up). **[new 2016]**

1.2.4.8 People in the groups listed in recommendation 1.2.4.1 who do not have treatment for latent TB, as specified in recommendations 1.2.4.2 to 1.2.4.8, for any reason should be advised of the risks and symptoms of TB (on the basis of an individual risk assessment), usually in a standard letter of the type referred to as 'Inform and advise' information (see section 1.1.2). **[new 2016]**

1.2.5 Managing latent TB in adults

1.2.5.1 For adults between the ages of 35 and 65 years, offer drug treatments only if hepatotoxicity is not a concern. **[new 2016]**

1.2.5.2 Offer testing for HIV before starting treatment for latent TB. See the NICE guidelines on increasing the uptake of HIV testing among black Africans in England and increasing the uptake of HIV testing among men who have sex with men. **[new 2016]**

1.2.5.3 Offer adults testing for hepatitis B and C before starting treatment for latent TB. See the NICE guidelines on hepatitis B and C: ways to promote and offer testing to people at increased risk of infection and hepatitis B (chronic): diagnosis and management of chronic hepatitis B in children, young people and adults. **[new 2016]**

1.2.6 Managing latent TB in children and young people

1.2.6.1 Consider testing children and young people for hepatitis B and C before starting treatment for latent TB. See the NICE guidelines on hepatitis B and C: ways to promote and offer testing to people at increased risk of infection and hepatitis B (chronic): diagnosis and management of chronic hepatitis B in children, young people and adults. **[new 2016]**

1.3 Active TB

1.3.1 Diagnosing active TB in all age groups

1.3.1.1 If TB is a possibility, microbiology staff should consider carrying out TB culture on samples (see recommendations 1.3.2.2 and 1.3.2.3), even if it is not requested. **[2006, amended 2016]**

1.3.1.2 If there are clinical signs and symptoms consistent with a diagnosis of TB, start treatment without waiting for culture results. **[2006]**

1.3.1.3 Consider completing the standard recommended regimen (see recommendations 1.3.7.2 and 1.3.7.3 in the section on standard treatment), even if subsequent culture results are negative. **[2006, amended 2016]**

1.3.2 Diagnosing pulmonary (including laryngeal) TB in all age groups

1.3.2.1 Take a chest X-ray; do further diagnostic investigations (as detailed below and summarised in table 1) if chest X-ray appearances suggest TB. **[2016]**

1.3.2.2 Send multiple respiratory samples (3 deep cough sputum samples, preferably including 1 early morning sample) for TB microscopy and culture. **[2016]**

- This should be before starting treatment if possible or, failing that, within 7 days of starting treatment in people with life-threatening disease. **[2006,**

amended 2016]

- Obtain spontaneously-produced, deep cough sputum samples if possible, otherwise use:
  - 3 gastric lavages or 3 inductions of sputum in children and young people (see recommendation 1.5.1.10 in the section on infection control in healthcare settings) **[new 2016] or**
  - induction of sputum or bronchoscopy and lavage in adults. **[2006, amended 2016]**
- Laboratory practices should be in accordance with the UK's Standards for Microbiology Investigations. **[new 2016]**

1.3.2.3 Send samples for TB culture from autopsy samples if pulmonary or laryngeal TB is a possibility. **[2006, amended 2016]**

1.3.3 Diagnosing pulmonary (including laryngeal) TB in adults

1.3.3.1 Request rapid diagnostic nucleic acid amplification tests for the *M. tuberculosis* complex (*M. tuberculosis*, *M. bovis*, *M. africanum*) on primary specimens (listed in table 1) if there is clinical suspicion of TB disease, and:

- the person has HIV **or**
- rapid information about mycobacterial species would alter the person's care **or**
- the need for a large contact-tracing initiative is being explored. **[new 2016]**

1.3.4 Diagnosing pulmonary (including laryngeal) TB in children and young people

1.3.4.1 In children aged 15 years or younger with suspected pulmonary TB, offer rapid diagnostic nucleic acid amplification tests for the *M. tuberculosis* complex (*M. tuberculosis*, *M. bovis*, *M. africanum*). Usually only 1 nucleic acid amplification

test is needed per specimen type (for example, spontaneous sputum, induced sputum or gastric lavage; see table 1). **[new 2016]**

1.3.4.2 In young people aged 16 to 18 years use the same criteria as in adults to decide whether to request rapid diagnostic nucleic acid amplification tests (see table 1). **[new 2016]**

Table 1 Diagnostic investigations for pulmonary TB

Suspected site of disease	Possible imaging techniques	Specimen	Routine test	Additional tests (if it would alter management)
Pulmonary (adult)	X-ray (Routine test, see recommendation 1.3.2.1.) CT thorax Taking into account, for example, the exact site of suspected disease and the availability of the test at the time of assessment.	3 respiratory samples: • preferably spontaneously-produced, deep cough sputum samples, otherwise induced sputum or bronchoscopy and lavage • preferably 1 early morning sample	Microscopy Culture Histology	Nucleic acid amplification test

Suspected site of disease	Possible imaging techniques	Specimen	Routine test	Additional tests (if it would alter management)
Pulmonary (young people aged 16 to 17 years)	X-ray (Routine test, see recommendation 1.3.2.1.) CT thorax Taking into account, for example, the exact site of suspected disease and the availability of the test at the time of assessment.	3 respiratory samples: • preferably spontaneously-produced, deep cough sputum samples, otherwise induced sputum or gastric lavage • preferably 1 early morning sample	Microscopy Culture Histology	Nucleic acid amplification test
Pulmonary (children aged 15 years or younger)	X-ray (Routine test, see recommendation 1.3.2.1.) CT thorax Taking into account, for example, the exact site of suspected disease and the availability of the test at the time of assessment.	3 respiratory samples: • preferably spontaneously-produced, deep cough sputum samples, otherwise induced sputum or gastric lavage • preferably 1 early morning sample	Microscopy Culture Histology Nucleic acid amplification tests (1 per specimen type)	Interferon-gamma release assay and/or tuberculin skin test (with expert input)

1.3.4.3 Either a paediatrician with experience and training in TB or a general paediatrician with advice from a specialised clinician should investigate and manage TB in

children and young people. **[new 2016]**

1.3.4.4 An expert in paediatric TB may request interferon-gamma release assays and tuberculin skin tests. Interpret these together with other diagnostic tools (such as history taking, clinical examination and imaging). **[new 2016]**

1.3.5 Diagnosing extrapulmonary TB in all age groups

1.3.5.1 Discuss the advantages and disadvantages of both biopsy and needle aspiration with the patient, with the aim of obtaining adequate material for diagnosis. **[2006]**

1.3.5.2 Do not place part or all of any of the samples in formalin (or other fixative agent) when sending for TB culture. **[2006, amended 2016]**

1.3.5.3 Think about a diagnosis of extrapulmonary TB even if rapid diagnostic tests in, for example, cerebrospinal fluid, pleural fluid or ascitic fluid are negative. **[new 2016]**

1.3.5.4 Offer all patients presenting with extrapulmonary TB a chest X-ray and, if possible, culture of a spontaneously-produced respiratory sample to exclude or confirm coexisting pulmonary TB (see recommendations 1.3.1 to 1.3.3 in the section on active TB). Also, consider site-specific tests as described below to exclude or confirm additional sites of TB. **[new 2016]**

1.3.5.5 Refer to an expert for sites not listed here, including TB of the eye and other rare sites of disease. **[new 2016]**

Pleural TB

1.3.5.6 Use the site-specific investigations listed in table 2 to diagnose and assess pleural TB.

Table 2 Site-specific investigations for pleural TB

Suspected site of disease	Possible imaging techniques	Specimen	Routine test	Additional tests on primary specimen (if it would alter management)
Pleural	X-ray Bronchoscopy Taking into account, for example, the exact site of suspected disease and the availability of the test at the time of assessment.	3 respiratory samples: • preferably spontaneously-produced, deep cough sputum samples, otherwise induced sputum or gastric lavage • preferably 1 early morning sample Pleural biopsy	Microscopy Culture Histology	-
Pleural	X-ray Bronchoscopy Taking into account, for example, the exact site of suspected disease and the availability of the test at the time of assessment.	Pleural fluid	Microscopy Culture Cytology	Adenosine deaminase assay

[new 2016]

Central nervous system TB

1.3.5.7 Use the site-specific investigations listed in table 3 to diagnose and assess central nervous system TB.

Table 3 Site-specific investigations for central nervous system TB

Suspected site of disease	Possible imaging techniques[a]	Specimen	Routine test	Additional tests on primary specimen (if it would alter management)
Central nervous system	CT (Routine test, see recommendation 1.3.5.8) MRI (Routine test, see recommendation 1.3.5.8) Taking into account, for example, the exact site of suspected disease and the availability of the test at the time of assessment.	Biopsy of suspected tuberculoma	Microscopy Culture Histology	-
Central nervous system	CT (Routine test, see recommendation 1.3.5.8) MRI (Routine test, see recommendation 1.3.5.8) Taking into account, for example, the exact site of suspected disease and the availability of the test at the time of assessment.	Cerebrospinal fluid	Microscopy Culture Cytology	Adenosine deaminase assay

Suspected site of disease	Possible imaging techniques[a]	Specimen	Routine test	Additional tests on primary specimen (if it would alter management)
Meningeal	CT (Routine test, see recommendation 1.3.5.8) MRI (Routine test, see recommendation 1.3.5.8) Taking into account, for example, the exact site of suspected disease and the availability of the test at the time of assessment.	Cerebrospinal fluid	Microscopy Culture Cytology	Nucleic acid amplification test Adenosine deaminase assay

[new 2016]

1.3.5.8 Offer a CT or MRI scan to people in whom central nervous system involvement is suspected. **[2016]**

1.3.5.9 Offer treatment for TB meningitis if clinical signs and other laboratory findings are consistent with the diagnosis, even if a rapid diagnostic test is negative. **[new 2016]**

Lymph node TB (including intrathoracic mediastinal adenopathy)

1.3.5.10 Use the site-specific investigations listed in table 4 to diagnose and assess lymph node TB (including intrathoracic mediastinal adenopathy).

Table 4 Site-specific investigations for lymph node TB

Suspected site of disease	Possible imaging techniques	Specimen	Routine test	Additional tests on primary specimen (if it would alter management)
Lymph node (including intrathoracic mediastinal adenopathy)	Ultrasound CT MRI Taking into account, for example, the exact site of suspected disease and the availability of the test at the time of assessment.	Biopsy	Microscopy Culture Histology	Nucleic acid amplification test
		Aspirate	Microscopy Culture Cytology	Nucleic acid amplification test

[new 2016]

Pericardial TB

1.3.5.11 Use the site-specific investigations listed in table 5 to diagnose and assess pericardial TB.

Table 5 Site-specific investigations for pericardial TB

Suspected site of disease	Possible imaging techniques	Specimen	Routine test	Additional tests on primary specimen (if it would alter management)
Pericardial	Echocardiogram Taking into account, for example, the exact site of suspected disease and the availability of the test at the time of assessment.	Biopsy of pericardium	Microscopy Culture Histology	-
Pericardial	Echocardiogram Taking into account, for example, the exact site of suspected disease and the availability of the test at the time of assessment.	Pericardial fluid	Microscopy Culture Cytology	Nucleic acid amplification test Adenosine deaminase assay

[new 2016]

Gastrointestinal TB

1.3.5.12 Use the site-specific investigations listed in table 6 to diagnose and assess gastrointestinal TB.

Table 6 Site-specific investigations for gastrointestinal TB

Suspected site of disease	Possible imaging techniques	Specimen	Routine test	Additional tests on primary specimen (if it would alter management)
Gastrointestinal	Ultrasound CT Laparoscopy Taking into account, for example, the exact site of suspected disease and the availability of the test at the time of assessment.	Biopsy of omentum Biopsy of bowel Biopsy of liver	Microscopy Culture Histology	-
Gastrointestinal	Ultrasound CT Laparoscopy Taking into account, for example, the exact site of suspected disease and the availability of the test at the time of assessment.	Ascitic fluid	Microscopy Culture Cytology	Adenosine deaminase assay

[new 2016]

Genitourinary TB

1.3.5.13 Use the site-specific investigations listed in table 7 to diagnose and assess genitourinary TB.

Table 7 Site-specific investigations for genitourinary TB

Suspected site of disease	Possible imaging techniques	Specimen	Routine test	Additional tests on primary specimen (if it would alter management)
Genitourinary	Ultrasound Intravenous urography Laparoscopy Taking into account, for example, the exact site of suspected disease and the availability of the test at the time of assessment.	Early morning urine	Culture	-
Genitourinary	Ultrasound Intravenous urography Laparoscopy Taking into account, for example, the exact site of suspected disease and the availability of the test at the time of assessment.	Biopsy from site of disease, such as endometrial curettings or renal biopsy	Microscopy Culture Histology	-

[new 2016]

Bone and joint TB

1.3.5.14 Use the site-specific investigations listed in table 8 to diagnose and assess bone and joint TB.

Table 8 Site-specific investigations for bone and joint TB

Suspected site of disease	Possible imaging techniques	Specimen	Routine test	Additional test on primary specimen (if it would alter management)
Bone or joint TB	X-ray CT MRI Taking into account, for example, the exact site of suspected disease and the availability of the test at the time of assessment	Biopsy or aspirate of paraspinal abscess Biopsy of joint Aspiration of joint fluid	Culture	-

[new 2016]

Disseminated TB

1.3.5.15 Use the site-specific investigations listed in table 9 to diagnose and assess disseminated TB.

Table 9 Site-specific investigations for disseminated TB

Suspected site of disease	Possible imaging techniques	Specimen	Routine test	Additional tests on primary specimen (if it would alter management)
Disseminated	CT of the thorax and head MRI Ultrasound of the abdomen Taking into account, for example, the exact site of suspected disease and the availability of the test at the time of assessment.	Biopsy of site of disease, including lung, liver and bone marrow	Microscopy Culture Histology	Additional tests appropriate to site
Disseminated	CT of the thorax and head MRI Ultrasound of the abdomen Taking into account, for example, the exact site of suspected disease and the availability of the test at the time of assessment.	Aspirate bone marrow Bronchial wash Cerebrospinal fluid	Microscopy (if sample available) Culture Cytology	Additional tests appropriate to site
Disseminated	CT of the thorax and head MRI Ultrasound of the abdomen Taking into account, for example, the exact site of suspected disease and the availability of the test at the time of assessment.	Blood	Culture	Additional tests appropriate to site

[new 2016]

Skin TB

1.3.5.16 Use the site-specific investigations listed in table 10 to diagnose and assess skin TB.

Table 10: Site-specific investigations for skin TB

Suspected site of disease	Possible imaging techniques	Specimen	Routine test	Additional tests on primary specimen (if it would alter management)
Skin	-	Biopsy	Microscopy Culture Histology	-

[2016]

Localised tuberculous abscess

1.3.5.17 Use the site-specific investigations listed in table 11 to diagnose and assess TB in a localised, tuberculous abscess at a site other than a lymph node.

Table 11: Site-specific investigations for localised tuberculous abscess

Suspected site of disease	Possible imaging techniques	Specimen	Routine test	Additional tests on primary specimen (if it would alter management)
Abscess outside of the lymph nodes	Ultrasound or other appropriate imaging Taking into account, for example, the exact site of suspected disease and the availability of the test at the time of assessment	Aspirate	Microscopy Culture Cytology	-
Abscess outside of the lymph nodes	Ultrasound or other appropriate imaging Taking into account, for example, the exact site of suspected disease and the availability of the test at the time of assessment	Biopsy	Microscopy Culture Histology	-

[2016]

1.3.6 Rapid-access radiology and other investigation results: referral to multidisciplinary TB team process

1.3.6.1 Local hospitals, clinical commissioning groups and the local multidisciplinary team should consider developing a local pathway for people with imaging highly suggestive of active TB. The pathway should enable them to be referred by the radiology department by the next working day to multidisciplinary TB teams. Consider including the following in the pathway:

- Agreed standardised radiology codes to identify imaging investigations highly suggestive of active TB.

- Regular liaison between multidisciplinary TB teams and the radiology department (for example, weekly) to ensure all patients have been referred to the multidisciplinary team for triage using the agreed local mechanism or pathway. **[new 2016]**

1.3.6.2 Report results of all pathology or other diagnostic results suggesting TB to the multidisciplinary TB team and clinicians who ask for them. **[new 2016]**

Direct referral from emergency departments to multidisciplinary TB teams

1.3.6.3 Commissioners and multidisciplinary teams should consider working with emergency departments to develop direct referral pathways for people with suspected active TB so that:

- the local multidisciplinary team is informed of all suspected cases of TB using the appropriate process
- referral is accepted from any appropriate healthcare professional, for example an on-call radiologist. **[new 2016]**

1.3.6.4 Emergency department clinicians should ensure first-line diagnostic tests for TB are performed on anyone presenting with suspected TB (see table 1 on diagnostic investigations for pulmonary TB). **[new 2016]**

1.3.6.5 Emergency departments should consider carrying out audits of their direct referrals because of suspected active TB and the outcomes of diagnosis. **[new 2016]**

1.3.6.6 Multidisciplinary TB teams should consider training emergency department staff in:

- using approaches that do not stigmatise people with TB
- giving people with TB appropriate advice (see recommendations 1.1.1 and 1.1.2 in the section on raising and sustaining awareness of TB and the section on infection control). **[new 2016]**

1.3.7 Managing active TB in all age groups

Standard treatment

1.3.7.1 Once a diagnosis of active TB is made:

- the clinician responsible for care should refer the person with TB to a clinician with training in, and experience of, the specialised care of people with TB
- the TB service should include specialised nurses and health visitors
- active TB in children should be managed by a TB specialist (see recommendation 1.3.4.3 in the section on diagnosing pulmonary (including laryngeal) TB in children and young people), and by paediatric trained nursing staff, where possible.

  If these arrangements are not possible, seek advice from more specialised colleagues throughout the treatment period. **[2016]**

1.3.7.2 For people with active TB without central nervous system involvement, offer:

- isoniazid (with pyridoxine), rifampicin, pyrazinamide and ethambutol for 2 months **then**
- isoniazid (with pyridoxine) and rifampicin for a further 4 months.

  Modify the treatment regimen according to drug susceptibility testing. **[2016]**

1.3.7.3 For people with active TB of the central nervous system, offer:

- isoniazid (with pyridoxine), rifampicin, pyrazinamide and ethambutol for 2 months **then**
- isoniazid (with pyridoxine) and rifampicin for a further 10 months.

  Modify the treatment regimen according to drug susceptibility testing. **[2016]**

1.3.7.4 Test people with active spinal TB who have neurological signs or symptoms for central nervous system involvement (see recommendation 1.3.5.8 in the section

on central nervous system TB). Manage direct spinal cord involvement (for example, a spinal cord tuberculoma) as TB of the central nervous system. **[2016]**

1.3.7.5 For people with active spinal TB without central nervous system involvement, do not extend treatment beyond 6 months for residual effects (for example, persistent bending of the spine or vertebral loss). **[2016]**

1.3.7.6 Test people with disseminated (including miliary) TB who have neurological signs or symptoms for central nervous system involvement. If there is evidence of central nervous system involvement, treat as for TB of the central nervous system. **[2016]**

1.3.7.7 Treat active peripheral lymph node TB in people who have had an affected gland surgically removed with the standard recommended regimen. **[new 2016]**

1.3.7.8 For people with active TB of the lymph nodes, do not routinely extend treatment beyond 6 months for newly enlarged lymph nodes or sinus formation, or for residual enlargement of the lymph nodes or sinuses. **[new 2016]**

Dosing of regimens

1.3.7.9 Use fixed-dose combination tablets as part of any TB treatment regimen. **[2006]**

1.3.7.10 Do not offer anti-TB treatment dosing regimens of fewer than 3 times per week. **[2006, amended 2016]**

1.3.7.11 Offer a daily dosing schedule to people with active pulmonary TB. **[2006, amended 2016]**

1.3.7.12 Consider a daily dosing schedule as first choice in people with active extrapulmonary TB. **[2006, amended 2016]**

1.3.7.13 Consider 3 times weekly dosing for people with active TB only if:

- a risk assessment identifies a need for directly observed therapy and enhanced case management (see section on adherence, treatment completion and follow-up) **and**

- daily directly observed therapy is not possible. **[2006, amended 2016]**

People with comorbidities or coexisting conditions

1.3.7.14 If the person has a comorbidity or coexisting condition such as:

- HIV **or**
- severe liver disease, for example, Child-Pugh level B or C **or**
- stage 4 or 5 chronic kidney disease (a glomerular filtration rate of <30 ml/minute/1.73m^2) **or**
- diabetes **or**
- eye disease or impaired vision **or**
- pregnancy or breastfeeding **or**
- a history of alcohol or substance misuse

work with a specialist multidisciplinary team with experience of managing TB and the comorbidity or coexisting condition. **[new 2016]**

1.3.7.15 For people with HIV and active TB without central nervous system involvement, do not routinely extend treatment beyond 6 months. **[new 2016]**

1.3.7.16 For people with HIV and active TB with central nervous system involvement, do not routinely extend treatment beyond 12 months. **[new 2016]**

1.3.7.17 Take into account drug-to-drug interactions when co-prescribing antiretroviral and anti-TB drugs. **[new 2016]**

Adjunctive corticosteroids

Central nervous system TB

1.3.7.18 At the start of an anti-TB treatment regimen, offer people with active TB of the central nervous system dexamethasone or prednisolone, initially at a high dose with gradual withdrawal over 4 to 8 weeks. An example of a suitable regimen is listed in table 12.

Table 12 Example of suitable corticosteroid regimen for adults

Dose of dexamethasone by week	Stage 1	Stage 2 or 3
Week 1	0.3 mg/kg/day (intravenous)	0.4 mg/kg/day (intravenous)
Week 2	0.2 mg/kg/day (intravenous)	0.3 mg/kg/day (intravenous)
Week 3	0.1 mg/kg/day (oral)	0.2 mg/kg/day (intravenous)
Week 4	3 mg/day (oral)	0.1 mg/kg/day (intravenous)
Week 5	2 mg/day (oral)	4 mg/day (oral)
Week 6	1 mg/day (oral)	3 mg/day (oral)
Week 7	-	2 mg/day (oral)
Week 8	-	1 mg/day (oral)

According to the modified British Medical Research Council criteria for disease severity:

Stage 1: Glasgow coma score of 15 without focal neurological deficits; alert and oriented.

Stage 2: Glasgow coma score of 14 to 11 or 15 with focal neurological deficits.

Stage 3: Glasgow coma score of 10 or less, with or without focal neurological deficits.

[new 2016]

1.3.7.19 At the start of an anti-TB treatment regimen, offer children and young people with active TB of the central nervous system dexamethasone or prednisolone. This should initially be at a high dose with gradual withdrawal over 4 to 8 weeks in line with the British National Formulary for Children. **[new 2016]**

Pericardial TB

1.3.7.20 At the start of an anti-TB treatment regimen, offer adults with active pericardial TB oral prednisolone at a starting dose of 60 mg/day, gradually withdrawing it 2 to 3 weeks after starting treatment. **[2016]**

1.3.7.21 At the start of an anti-TB treatment regimen, offer children and young people with active pericardial TB oral prednisolone in line with the British National Formulary for Children. Gradually withdraw prednisolone 2 to 3 weeks after starting treatment. **[2016]**

Adjunctive surgery

1.3.7.22 If surgery is indicated, the surgeon should fully explain what is involved to the person, either with or after consulting a TB specialist. Discuss the possible benefits and risks with the person and their family members or carers, as appropriate, so that they can make an informed decision. **[new 2016]**

Central nervous system TB

1.3.7.23 Consider referring people with TB of the central nervous system for surgery as a therapeutic intervention only if there is evidence of raised intracranial pressure. **[new 2016]**

Spinal TB

1.3.7.24 Do not routinely refer people with spinal TB for surgery to eradicate the disease. **[new 2016]**

1.3.7.25 Consider referring people with spinal TB for surgery if there is spinal instability or evidence of spinal cord compression. **[new 2016]**

1.4 Drug resistant TB

1.4.1 Multidrug-resistant TB

1.4.1.1 For people with clinically suspected TB, a TB specialist should request rapid diagnostic nucleic acid amplification tests for rifampicin resistance on primary specimens if a risk assessment for multidrug resistance identifies any of the following risk factors:

- history of previous TB drug treatment, particularly if there was known to be poor adherence to that treatment
- contact with a known case of multidrug-resistant TB
- birth or residence in a country in which the World Health Organization reports that a high proportion (5% or more) of new TB cases are multidrug-resistant.

Start infection control measures (see section 1.5). **[new 2016]**

1.4.1.2 If the rapid diagnostic nucleic acid amplification test for rifampicin resistance is positive:

- continue infection control measures until pulmonary or laryngeal disease has been excluded
- manage treatment along with a multidisciplinary team with experience of managing multidrug-resistant TB (see the section on service organisation)
- offer a treatment regimen involving at least 6 drugs to which the mycobacterium is likely to be sensitive

- test for resistance to second-line drugs. **[new 2016]**

1.4.1.3 If the rapid diagnostic nucleic acid amplification test for the *M. tuberculosis* complex is positive but rifampicin resistance is not detected, treat as drug-susceptible TB with the standard regimen (see the section on managing active TB in all age groups). **[new 2016]**

1.4.1.4 If the rapid diagnostic nucleic acid amplification test for the *M. tuberculosis* complex is negative in a person at high risk of multidrug-resistant TB:

- obtain further specimens for nucleic acid amplification testing and culture, if possible
- use rapid rifampicin resistance detection on cultures that become positive for the *M. tuberculosis* complex
- consider waiting for the results of further tests before starting treatment if the person is well
- if urgent treatment is needed, consider managing as multidrug-resistant TB until sensitivity results are available. **[new 2016]**

1.4.1.5 When definitive phenotypic susceptibility results are available, modify treatment as needed (see sections on managing active TB in all age groups and drug-resistant TB). **[new 2016]**

1.4.1.6 Consider more intensive clinical follow-up for people with multidrug-resistant TB. This includes people having directly observed therapy (see the section on adherence, treatment completion and follow-up) throughout treatment because of the complexity of treatment and risk of adverse events. **[new 2016]**

1.4.1.7 Discuss the options for organising care for people with multidrug-resistant TB with clinicians who specialise in this. Seek the person's views and take them into account, and consider shared care (see the section on service organisation). **[2006]**

1.4.1.8 Consider surgery as a therapeutic intervention in people with potentially resectable multidrug-resistant disease if:

- optimal medical therapy under direct observation has not worked **or**
- medical therapy is likely to fail because of extensively drug-resistant TB. **[new 2016]**

1.4.2 Drug-resistant TB (excluding multidrug- and extensively drug-resistant TB)

1.4.2.1 For people with TB, without central nervous system involvement, that is resistant to just 1 drug consider the treatments in table 13.

Table 13 Treatment regimen for people with TB that is resistant to 1 drug

Drug resistance	First 2 months (initial phase)	Continue with (continuation phase)
Isoniazid	Rifampicin, pyrazinamide and ethambutol	Rifampicin and ethambutol for 7 months (up to 10 months for extensive disease)
Pyrazinamide	Rifampicin, isoniazid (with pyridoxine) and ethambutol	Rifampicin and isoniazid (with pyridoxine) for 7 months
Ethambutol	Rifampicin, isoniazid (with pyridoxine) and pyrazinamide	Rifampicin and isoniazid (with pyridoxine) for 4 months
Rifampicin	As for multidrug-resistant TB	As for multidrug-resistant TB

[new 2016]

1.4.2.2 For people with drug-resistant TB and central nervous system involvement, involve a TB specialist with experience in managing drug-resistant TB in decisions about the most appropriate regimen and the duration of treatment. **[new 2016]**

1.5 Infection control

NICE has also produced general guidelines on the prevention and control of healthcare-associated infections in primary and community care, and the prevention and control of healthcare-associated infections.

1.5.1 Healthcare settings

1.5.1.1 Ensure healthcare settings can promptly identify people with suspected infectious or confirmed pulmonary or laryngeal TB before or at presentation. Ensure people working in the settings follow the recommendations about testing and treatments (see the sections on latent TB, active TB and drug resistant TB*)*. **[new 2016]**

1.5.1.2 Put people with suspected infectious or confirmed pulmonary or laryngeal TB who will remain in a hospital setting (including emergency, outpatients or inpatient care) in a single room. If this is not possible, keep the person's waiting times to a minimum. This may involve prioritising their care above that of other patients. **[new 2016]**

1.5.1.3 Minimise the number and duration of visits a person with TB makes to an outpatient department while they are still infectious. To minimise the risk of infection, people with infectious TB should be seen at times or in places away from other people. **[new 2016]**

1.5.1.4 In hospital settings, risk assess people with suspected infectious or confirmed pulmonary TB for multidrug-resistant TB *(*see the section on multidrug-resistant TB). Care for people deemed to be at low risk in a single room, as a minimum. For people deemed to be at high risk:

- provide care in a negative pressure room **and**
- have specimens sent for rapid diagnostic tests, such as nucleic acid amplification tests. **[new 2016]**

1.5.1.5 Unless there is a clear clinical or public health need, such as homelessness, people with suspected infectious or confirmed pulmonary TB should not be admitted to hospital for diagnostic tests or for care. **[2006, amended 2016]**

1.5.1.6 Do not admit people with suspected infectious or confirmed pulmonary TB to a ward containing people who are immunocompromised, such as transplant recipients, people with HIV and those on anti-tumour necrosis factor alpha or other biologics, unless they can be cared for in a negative pressure room on the same ward. **[new 2016]**

1.5.1.7 Assess any visitors to a child with suspected active TB in hospital for symptoms of infectious TB, and keep them separate from other people until they have been excluded as a source of infection (see recommendations 1.2.1 to 1.2.3 in the section on latent TB and the section on contact tracing). **[new 2016]**

1.5.1.8 Care for people with a continuing clinical or public health need for admission with pulmonary TB in a single room (as a minimum) until they have completed 2 weeks of the standard treatment regimen (see the section on managing active TB in all age groups) if they:

- are unlikely to be rifampicin resistant (that is, do not have risk factors for multidrug-resistant TB) **or**
- have negative rifampicin resistance on nucleic acid amplification test or culture. **[new 2016]**

1.5.1.9 Consider de-escalating isolation after 2 weeks of treatment, taking into account the risks and benefits, if:

- the person is showing tolerance to the prescribed treatment
- there is agreement to adhere to treatment
- there is resolution of cough
- there is definite clinical improvement on treatment; for example, remaining afebrile for a week
- there are not immunocompromised people, such as transplant recipients, people with HIV and those on anti-tumour necrosis factor alpha or other biologics, in the same accommodation
- the person's initial smear grade was not high; for example, 2 or less

- there is not extensive pulmonary involvement, including cavitation
- there is no laryngeal TB. **[new 2016]**

1.5.1.10 In people who may have TB, only carry out aerosol-generating procedures such as bronchoscopy, sputum induction or nebuliser treatment in an appropriately engineered and ventilated area (ideally a negative pressure room). **[new 2016]**

1.5.1.11 Consider discharging from hospital people:

- who do not have a continuing clinical or public health need for admission with pulmonary TB **and**
- who are unlikely to be rifampicin resistant (that is, do not have risk factors for multidrug-resistant TB) **or**
- who have negative rifampicin resistance on nucleic acid amplification test or culture.

  If discharged, the person should avoid congregate settings for the first 2 weeks of their treatment. **[new 2016]**

1.5.1.12 Explain to inpatients with suspected infectious or confirmed pulmonary or laryngeal TB that they will need to wear a surgical mask in the hospital whenever they leave their room. Ask them to continue wearing it until they have had at least 2 weeks of treatment. **[2016]**

1.5.1.13 Offer people advice on simple respiratory hygiene measures. **[new 2016]**

1.5.2 Non-healthcare settings

1.5.2.1 In non-healthcare settings catering for large numbers of people and populations at high risk of TB (such as detention settings, residential hostels and day centres):

- promote simple respiratory hygiene
- ensure awareness of symptoms of potentially infectious TB to enable prompt

healthcare referral

- work with the local public health team and the local authority to ensure accommodation for people with TB
- ensure adequate ventilation. **[new 2016]**

1.5.2.2 In prisons or immigration removal centres, everyone with X-ray changes indicative of active TB, as well as those with symptoms who are awaiting X-ray, should be isolated in an adequately ventilated individual room or cell. Prisoners and detainees should be retained on medical hold until they have:

- proven smear-negative and had an X-ray that does not suggest active TB **or**
- had a negative risk assessment for multidrug-resistant TB and completed 2 weeks of the standard treatment regimen. **[2012, amended 2016]**

1.5.3 Multidrug-resistant TB

1.5.3.1 If people with suspected or known infectious multidrug-resistant TB are admitted to hospital, admit them to a negative pressure room. If none is available locally, transfer them to a hospital that has these facilities and a clinician experienced in managing complex drug-resistant cases. Carry out care in a negative pressure room for people with:

- suspected multidrug-resistant TB, until non-resistance is confirmed
- confirmed multidrug-resistant TB, until they have 3 negative smears at weekly intervals and ideally have a negative culture. **[new 2016]**

1.5.3.2 As soon as possible, explore options to reduce the psychosocial impact of prolonged isolation. For example, through providing free access to internet, telephone and television, and accompanied walks in the open air. **[new 2016]**

1.5.3.3 Consider earlier discharge for people with confirmed multidrug-resistant TB, if there are suitable facilities for home isolation and the person will adhere to the care plan. **[new 2016]**

1.5.3.4 For people with confirmed multidrug-resistant TB whose symptoms have improved and who are unable to produce sputum, discharge decisions should be taken by the multidisciplinary team and the health protection team. **[new 2016]**

1.5.3.5 Staff and visitors should wear filtering face piece (FFP3) masks during contact with a person with suspected or known multidrug-resistant TB while the person is thought to be infectious. **[2016]**

1.5.3.6 Before deciding to discharge a person with suspected or known multidrug-resistant TB from hospital, agree with the person and their carers secure arrangements for supervising and administering all anti-TB therapy. **[2016]**

1.5.3.7 Discuss the decision to discharge a person with suspected or known multidrug-resistant TB with:

- the infection control team **and**
- the local microbiologist **and**
- the local TB service **and**
- the health protection team. **[2016]**

1.5.3.8 Ensure negative pressure rooms used for infection control in multidrug-resistant TB meet the standards of the Interdepartmental Working Group on Tuberculosis, and are clearly identified for staff, for example by a standard sign. Keep such signs up to date. **[2016]**

1.6 Case finding

1.6.1 Contact tracing

Human to human transmission

1.6.1.1 Once a person has been diagnosed with active TB, the diagnosing physician

should inform relevant colleagues so that the need for contact tracing can be assessed without delay. Contact tracing should not be delayed until notification. **[2006]**

1.6.1.2 Offer screening to the close contacts of any person with pulmonary or laryngeal TB. **[2006, amended 2016]**

1.6.1.3 Assess symptomatic close contacts for active TB (see recommendations 1.3.1 to 1.3.4 in the section on active TB). **[new 2016]**

1.6.1.4 In asymptomatic close contacts younger than 65 years, consider standard testing for latent TB (see recommendations 1.2.1 to 1.2.3 in the section on latent TB), followed by consideration of BCG vaccination in line with the section on BCG vaccination or treatment for latent TB infection (see recommendations 1.2.4 to 1.2.6 in the section on latent TB) once active TB has been ruled out for people who:

- are previously unvaccinated **and**
- are contacts of a person with smear-positive pulmonary or laryngeal TB **and**
- are Mantoux-negative.

  At the time of publication (January 2016) the BNF states: 'The Mantoux test is recommended for tuberculin skin testing, but no licensed preparation is currently available.' For further guidance, see immunisation against infectious disease (the Green book). **[2006, amended 2016]**

1.6.1.5 In asymptomatic close contacts older than 65 years, consider a chest X-ray (if there are no contraindications), possibly leading to further investigation for active TB. **[2006, amended 2016]**

1.6.1.6 Do not routinely assess social contacts of people with TB, who will include most workplace contacts. **[2006, amended 2016]**

1.6.1.7 Assess the need for tracing social contacts of people with pulmonary or laryngeal TB if:

- the index case is judged to be particularly infectious (for example, evidenced

by transmission to close contacts) **or**

- any social contacts are known to possess features that put them at high risk of going on to develop active TB. **[2006, amended 2016]**

1.6.1.8 Offer 'inform and advise' information to close and social contacts of people with smear-positive TB (see section on providing information for the public about TB). **[2006]**

Cases on an aircraft

1.6.1.9 After diagnosis of TB in an aircraft traveller, do not routinely carry out contact tracing of fellow passengers. **[2006, amended 2016]**

1.6.1.10 The notifying clinician should inform the relevant consultant in communicable disease control or health protection if:

- less than 3 months has elapsed since the flight and the flight was longer than 8 hours **and**
- the index case is smear-positive **and either**
  - the index case has multidrug-resistant TB **or**
  - the index case coughed frequently during the flight. **[2006]**

1.6.1.11 The consultant in communicable disease control or health protection should provide the airline with 'inform and advise' information to send to passengers seated in the same part of the aircraft as the index case. **[2006, amended 2016]**

1.6.1.12 If the TB index case is an aircraft crew member, contact tracing of passengers should not routinely take place. **[2006]**

1.6.1.13 If the TB index case is an aircraft crew member, contact tracing of other members of staff is appropriate, in accordance with the usual principles for screening workplace colleagues. **[2006]**

Cases in schools

1.6.1.14 After diagnosis of TB in a school pupil or member of staff, the consultant in communicable disease control or health protection should be prepared to explain the prevention and control procedures to staff, parents and the press. Advice on managing these incidents and their public relations is available from the Public Health England health protection team and the local authority. **[2006, amended 2016]**

1.6.1.15 If a school pupil is diagnosed with smear-positive TB, carry out a risk assessment of the need to test the rest of his or her class (if there is a single class group), or the rest of the year group who share classes, as part of contact tracing. **[2006]**

1.6.1.16 If a teacher has smear-positive TB, assess the pupils in his or her classes during the preceding 3 months as part of contact tracing. **[2006]**

1.6.1.17 Consider extending contact tracing in schools to include children and teachers involved in extracurricular activities, and non-teaching staff, on the basis of:

- the degree of infectivity of the index case
- the length of time the index case was in contact with others
- whether contacts are unusually susceptible to infection
- the proximity of contact. **[2006, amended 2016]**

1.6.1.18 Treat secondary cases of smear-positive TB as index cases for contact tracing. **[2006]**

1.6.1.19 If the index case of a school pupil's TB infection is not found, and the child is not in a high-risk group for TB, contact tracing and screening (by either symptom enquiry or chest X-ray) should be considered for all relevant members of staff at the school. **[2006]**

Cases in community childcare

1.6.1.20 When an adult who works in childcare (including people who provide childcare

informally) is diagnosed with smear-positive TB, follow recommendations 1.6.1.1 to 1.6.1.8. **[2006, amended 2016]**

Cases in hospital inpatients

1.6.1.21 If TB is diagnosed in a hospital inpatient, do a risk assessment. This should take into account:

- the degree of infectivity of the index case
- the length of time before the infectious patient was isolated
- whether other patients are unusually susceptible to infection
- the proximity of contact. **[2006, amended 2016]**

1.6.1.22 Carry out contact tracing and testing only for patients for whom the risk is regarded as significant. **[2006]**

1.6.1.23 Regard patients as at risk of infection if they spent more than 8 hours in the same bay as an inpatient with smear-positive TB who had a cough. Document the risk in the contact's clinical notes, for the attention of the contact's consultant. Give the contact 'inform and advise' information, and inform their GP. **[2006]**

1.6.1.24 If patients were exposed to a patient with smear-positive TB for long enough to be equivalent to close contacts (as determined by the risk assessment), or an exposed patient is known to be particularly susceptible to infection, manage their TB risk in the same way as close contacts. **[2006, amended 2016]**

1.6.1.25 If an inpatient with smear-positive TB is found to have multidrug-resistant TB, or if exposed patients are HIV positive, trace contacts following the Interdepartmental Working Group on Tuberculosis guidelines. **[2006]**

1.6.1.26 In cases of doubt when planning contact tracing after diagnosing smear-positive TB in an inpatient, seek further advice from the local or national Public Health England or Wales unit or people experienced in the field. **[2006, amended 2016]**

1.6.2 Opportunistic case finding

New entrants from high incidence countries

1.6.2.1 Assess and manage TB in new entrants from high incidence countries who present to healthcare services as follows:

- assess risk of HIV, including HIV prevalence rates in the country of origin, and take this into account when deciding whether to give a BCG vaccination
- offer testing for latent TB (see recommendations 1.2.1 to 1.2.3 in the section on latent TB)
- assess for active TB if the test for latent TB is positive (see recommendations 1.3.1 to 1.3.5 in the section on active TB)
- offer treatment to people aged 65 years or younger in whom active TB has been excluded but who have a positive Mantoux test or a positive interferon-gamma release assay for latent TB infection (see recommendations 1.2.4 to 1.2.6 in the section on latent TB)
- consider offering BCG for unvaccinated people who are Mantoux- or interferon-gamma release assay-negative (see the section on BCG vaccination)
- give 'inform and advise' information to people who do not have active TB and are not being offered BCG or treatment for latent TB infection (see the section on providing information for the public about TB). **[2006, amended 2011 and 2016]**

1.6.2.2 Primary care services should support local, community-based and voluntary organisations that work with vulnerable migrants to ensure they:

- register with a primary care provider
- know how to use NHS services (emergency or primary care). **[2012]**

1.6.2.3 Healthcare professionals, including primary care staff, responsible for testing new entrants should test all vulnerable migrants who have not previously been checked. This is regardless of when they arrived in England. People born in

countries with an incidence of more than 150 per 100,000 per year should be made a priority for latent TB testing when they arrive here. **[2012, amended 2016]**

People using homeless or substance misuse services

1.6.2.4 In areas of identified need (see the section on local needs assessment), including major urban centres with a high incidence of TB, commissioners should:

- ensure there is a programme of active case-finding using mobile X-ray in places where homeless people and people who misuse substances congregate (this includes: homeless day centres, rolling shelters, hostels and temporary shelters established as part of cold weather initiatives and venues housing needle and syringe programmes)
- base the frequency of screening at any 1 location on population turnover
- where local demand does not warrant a mobile X-ray team, consider commissioning mobile X-ray capacity from another area. **[2006, amended 2012]**

1.6.2.5 Multidisciplinary TB teams should consider using simple incentives, such as providing hot drinks and snacks, to encourage people to attend for testing. **[2006, amended 2012, amended 2016]**

1.6.2.6 Commissioners of TB prevention and control programmes should consider offering people who are homeless and people who misuse substances other health interventions when they are screened for TB at a mobile X-ray unit. (Examples may include blood-borne virus screening, dentistry and podiatry services.) **[2012]**

1.6.2.7 Multidisciplinary TB teams should work closely with mobile X-ray teams and frontline staff in hostels and day centres to promote TB screening and to ensure appropriate onward referrals and follow-up. **[2012]**

1.6.2.8 Multidisciplinary TB teams should consider using peer educators to promote the uptake of TB screening in hostels and day centres. **[2012]**

1.6.2.9 Multidisciplinary TB teams should provide routine data to TB control boards on: screening uptake, referrals and the number of active TB cases identified. **[2012]**

People in prisons or immigration removal centres

1.6.2.10 Healthcare professionals in prisons and immigration removal centres should ensure prisoners and detainees are screened for TB within 48 hours of arrival. **[2012]**

1.6.2.11 Prisons with Department of Health-funded static digital X-ray facilities for TB screening should X-ray all new prisoners and detainees (including those being transferred from other establishments) if they have not had a chest X-ray in the past 6 months. This should take place within 48 hours of arrival. **[2012]**

1.6.2.12 Prison and immigration removal centre health staff should report all suspected and confirmed TB cases to the local multidisciplinary TB team within 1 working day. **[2012]**

1.6.2.13 Multidisciplinary TB staff should visit every confirmed TB case in a prison or immigration removal centre in their locality within 5 working days. **[2012]**

1.6.2.14 If a case of active TB is identified, the local Public Health England unit, in conjunction with the multidisciplinary TB team, should plan a contact investigations exercise. They should also consider using mobile X-ray to check for further cases. **[2012]**

1.6.3 Active case finding in under-served groups

1.6.3.1 Multidisciplinary TB teams should follow NICE recommendations on contact tracing (see the section on contact tracing).They should coordinate contact investigations at places where the person with TB spends significant amounts of time. Examples could include pubs, crack houses, parks and community centres. The aim is to help identify people who have been living with them and people they frequently socialise with. **[2012]**

1.6.3.2 Multidisciplinary TB teams dealing with someone from an under-served group should work alongside health and social care professionals known to them to help trace relevant contacts. They should also work in partnership with voluntary, community and statutory organisations to conduct outreach contact investigations. **[2012]**

1.6.3.3 Multidisciplinary TB teams should, if available and appropriate, encourage peer educators or TB programme support workers to help with contact investigations involving under-served people who have complex social networks. **[2012]**

1.6.3.4 Multidisciplinary TB teams in discussion with local Public Health England health protection teams should consider using digital mobile X-ray for active case-finding in settings identified by looking at social networks as places where under-served people at risk congregate. They should also provide the necessary support so that multidisciplinary TB teams can use strain-typing and social network analysis to ascertain where transmission is occurring in the community. (Examples of transmission sites may include pubs, crack houses, hostels and day centres.) They should focus on active case-finding in the settings identified. **[2012, amended 2016]**

1.6.4 Incident and outbreak response

1.6.4.1 Multidisciplinary TB teams should coordinate incident or outbreak contact investigations at places where the person with active TB spends significant amounts of time. Examples include workplaces, schools, colleges, universities, childcare settings. Identify people that the person with TB frequently spends substantial time with, as outlined in the section on contact tracing. **[new 2016]**

1.6.4.2 Multidisciplinary TB teams should refer any incident in a congregate setting to the local Public Health England health protection team for risk assessment within 5 working days of suspicion of a potential incident. **[new 2016]**

1.6.4.3 TB control boards working with local health protection teams should, through local arrangements, mobilise existing staff or have access to an incident team that will:

- undertake an incident risk assessment and provide advice
- support or undertake contact investigations
- provide information and communication support to the multidisciplinary TB team, the local director of public health, the setting in which the incident has occurred and the people affected including:
  - written advice, printed or by email
  - question and answer sessions
  - telephone advice
  - media engagement
- gather and collate data, and report on outcomes to measure the effectiveness of the investigation (for example, offering testing to all people identified at risk and monitoring uptake)
- report back to TB control boards at appropriate times. This includes when outcomes of initial investigation of people classified as close contacts are available. It also includes when a decision is made to broaden the investigation to the next stage using the concentric circle method for risk assessment. **[new 2016]**

1.6.4.4 When incidents have been identified, multidisciplinary TB teams in discussion with local Public Health England health protection teams should consider providing support for strain-typing and other analysis to ascertain where transmission is occurring. (Examples of transmission sites may include workplaces, schools, colleges, universities, childcare settings.) **[new 2016]**

1.6.4.5 In all types of contact investigation scenarios (active case finding, incident or outbreak investigations) multidisciplinary TB teams should investigate all people who have been in contact with children who have pulmonary or extrapulmonary TB to identify the primary source of infection. If necessary, they should look beyond immediate close contacts to find the source. **[2012, amended 2016]**

1.7 Adherence, treatment completion and

follow-up

1.7.1 Improving adherence: case management including directly observed therapy

1.7.1.1 Allocate a named TB case manager to everyone with active TB as soon as possible after diagnosis (and within 5 days). The clinical team should tell each person who their named TB case manager is and provide contact details. **[2006, 2012 amended 2016]**

1.7.1.2 The TB case managers should work with the person diagnosed with TB to develop a health and social care plan, and support them to complete therapy successfully. The TB case manager should:

- offer a risk assessment to every person with TB, to identify their needs and whether they should have enhanced case management including directly observed therapy
- educate the person about TB and the treatment
- develop an individual care plan after discussion with the person
- gain the person's consent to the plan and agree a review date (for example, when moving from initiation to maintenance, or at each contact to ensure the person's needs are being met)
- coordinate discharge planning, especially for people on directly observed therapy
- involve representatives from other allied professions and key workers from all organisations who work with the person, if appropriate
- explore appropriate ways that peers and voluntary organisations can provide support. **[2006, 2012, amended 2016]**

1.7.1.3 Offer directly observed therapy as part of enhanced case management in people who:

- do not adhere to treatment (or have not in the past)

- have been treated previously for TB
- have a history of homelessness, drug or alcohol misuse
- are currently in prison, or have been in the past 5 years
- have a major psychiatric, memory or cognitive disorder
- are in denial of the TB diagnosis
- have multidrug-resistant TB
- request directly observed therapy after discussion with the clinical team
- are too ill to administer the treatment themselves. **[2012, amended 2016]**

1.7.1.4 In children whose parents are members of any of the above groups, offer directly observed therapy as part of enhanced case management and include advice and support for parents to assist with treatment completion. **[2016]**

1.7.1.5 Re-evaluate the need for directly observed therapy throughout the course of TB treatment whenever the person's (or in the case of children, parents') circumstances change. **[new 2016]**

1.7.1.6 TB case managers should ensure the health and social care plan (particularly if directly observed therapy is needed) identifies why a person may not attend for diagnostic testing or follow a treatment plan, and how they can be encouraged to do so. It should also include ways to address issues such as fear of stigmatisation, support needs and/or cultural beliefs, and may include information on:

- demographics (for example, age, nationality, place of birth, length of time in UK)
- all current prescribing regimens
- housing needs and living situation, including looked-after children
- substance misuse (drugs or alcohol)
- any contact with the criminal justice system

- the need for hepatitis B and C or HIV testing (see recommendations 1.2.5.2 and 1.2.5.3 in the section on managing latent TB in adults and recommendation 1.2.6.1 in the section on managing latent TB in children and young people)
- HIV status
- other health conditions (physical or mental)
- communication factors (for example, language and literacy levels)
- ability to access treatment (mobility and transport needs)
- employment or entitlement to benefits
- legal or immigration status (including risk of removal or relocation within the UK)
- any enablers or incentives to overcome anything that is stopping diagnosis or treatment. **[2012, amended 2016]**

1.7.1.7 The health and social care plan should:

- state who will be observing treatment and where (if the person is having directly observed therapy this should be provided at a location that is convenient and accessible to them, for example, at a methadone clinic) **[2012, amended 2016]**
- include actions to take if contact with the person is lost (for example, keeping details of people who might be able to help re-establish contact) **[2012]**
- refer to, and be coordinated with, any other care plan already established for the person **[2012]**
- define the support needed to address any unmet health and social care needs (for example, support to gain housing or other benefits, or to help them access other health or social care services) **[2012, amended 2016]**
- include a commitment from the person to complete their TB treatment **[2012, amended 2016]**

- be supported by frequent contact with any key workers who work with the person. **[2006 amended 2011, amended 2016]**

1.7.1.8 Multidisciplinary TB teams should aim to find people with active TB who are lost to follow-up, or who stop using services before completing diagnostic investigations. They should report all those lost to follow-up to local Public Health England teams, GPs, the referring organisation and specialist outreach teams. **[2012]**

1.7.2 Other strategies to encourage people to follow their treatment plan

1.7.2.1 To encourage people to follow their treatment plan, involve people in treatment decisions for active or latent TB from the start. Emphasise the importance of following the treatment plan when agreeing the regimen. **[2016]**

1.7.2.2 Multidisciplinary TB teams should implement strategies for active and latent TB to encourage people to follow the treatment plan and prevent people stopping treatment early. These could include:

- reminder letters, printed information, telephone calls, texts and apps using an appropriate language **[2006, amended 2016]**
- health education counselling and patient-centred interviews **[2006, amended 2016]**
- tailored health education booklets from quality sources (see section on providing information for the public about TB) **[2006, amended 2016]**
- home visits **[2006]**
- random urine tests and other monitoring (for example, pill counts) **[2006]**
- access to free TB treatment for everyone (irrespective of eligibility for other NHS care) and information about help with paying for prescriptions **[2006, 2012, amended 2016]**
- social and psychological support (including cultural case management and

broader social support) **[new 2016]**

- advice and support for parents and carers **[new 2016]**
- incentives and enablers to help people follow their treatment regimen. **[new 2016]**

1.7.2.3 TB control boards should ensure services take into account the barriers facing vulnerable migrants who may need treatment, and in particular the stigma they may face. Other issues include the location of services (both geographically and in terms of opening times) and people's language and cultural needs, in terms of the format of advice and the type of information given. **[2012, amended 2016]**

1.7.3 Strategies in prisons or immigration removal centres

1.7.3.1 On arrival at a prison or immigration removal centre, healthcare professionals should ask all prisoners and detainees (including those being transferred from other establishments) if they are taking TB medication, to ensure continuity of treatment. **[2012]**

1.7.3.2 All prisoners and immigration removal centre detainees having treatment for active TB should have a named TB case manager. The case manager should be responsible for contingency planning for discharge from prison or detention. **[2012]**

1.7.3.3 Prisons and immigration removal centres should ensure multidisciplinary TB staff have access to prisoners and detainees who need treatment (for example, by being given security clearance). **[2012]**

1.7.3.4 All prisoners having treatment for active TB should have directly observed therapy. **[2012]**

1.7.3.5 Prison health services should have contingency, liaison and handover arrangements to ensure continuity of care before any prisoner on TB treatment is transferred between prisons or released. In addition, other agencies working with prisoners or detainees should also be involved in this planning. **[2012]**

1.7.3.6 Prison and immigration removal centre healthcare services should liaise with the named TB case manager (from the multidisciplinary TB team) to ensure contingency plans for continuation of treatment are drawn up for prisoners and immigration removal centre detainees with TB. **[2012]**

1.7.3.7 Multidisciplinary TB teams should ensure accommodation is available for the duration of TB treatment after the prisoner or detainee's release (see section on Identifying and managing active TB in prisons, custody suites or immigration removal centres: organisational factors). **[2012]**

1.7.3.8 Multidisciplinary TB teams should ensure directly observed therapy is arranged for prisoners or detainees being treated for TB after their release. This should be available close to where they will live in the community. **[2012]**

1.7.4 Re-establishing treatment for active or latent TB after interruptions because of adverse events

1.7.4.1 In people who have experienced a treatment interruption because of drug-induced hepatotoxicity:

- investigate other causes of acute liver reactions **and**
- wait until aspartate or alanine transaminase levels fall below twice the upper limit of normal, bilirubin levels return to the normal range and hepatotoxic symptoms have resolved **then**
- sequentially reintroduce each of the anti-TB drugs at full dose over a period of no more than 10 days, starting with ethambutol and either isoniazid (with pyridoxine) or rifampicin. **[new 2016]**

1.7.4.2 In people with severe or highly infectious TB who need to interrupt standard therapy because of a reaction, consider continuing treatment:

- for hepatotoxicity, a combination of at least 2 anti-TB drugs of low hepatotoxicity (such as ethambutol and streptomycin, with or without a fluoroquinolone antibiotic, such as levofloxacin or moxifloxacin) and monitor with a liver specialist for further reactions

See MHRA advice for restrictions and precautions for using fluoroquinolone antibiotics due to very rare reports of disabling and potentially long-lasting or irreversible side effects affecting musculoskeletal and nervous systems. Warnings include: stopping treatment at first signs of a serious adverse reaction (such as tendonitis), prescribing with special caution in people over 60 years and avoiding coadministration with a corticosteroid (March 2019).

Not licensed for tuberculosis, so use would be off label. The prescriber should follow relevant professional guidance, taking full responsibility for the decision. Informed consent should be obtained and documented. See the General Medical Council's Good practice in prescribing and managing medicines and devices for further information.

- for a cutaneous reaction, a combination of at least 2 anti-TB drugs with a low risk of cutaneous reactions (such as ethambutol and streptomycin) and monitor with a dermatologist for further reactions. **[new 2016, amended 2019]**

1.7.4.3 If another reaction of a similar or greater severity occurs because of reintroducing a particular drug, do not give that drug in future regimens and consider extending the total regimen accordingly. **[new 2016]**

1.7.5 Follow-up after treatment completion

1.7.5.1 Follow-up clinic visits should not be conducted routinely after treatment completion. **[2006]**

1.7.5.2 Tell patients to watch for symptoms of relapse and how to contact the TB service rapidly through primary care or a TB clinic. Key workers should ensure that patients at increased risk of relapse are particularly well informed about symptoms. **[2006]**

1.7.5.3 Patients who have had drug-resistant TB should be considered for follow-up for 12 months after completing treatment. Patients who have had multidrug-resistant TB should be considered for prolonged follow-up. **[2006]**

1.8 Service organisation

When using the recommendations in this section with under served groups, also check sections 1.1.1 on raising and sustaining awareness, 1.1.2 on providing information for the public, 1.6.2 on opportunistic case finding, 1.6.3 on active case finding in under served groups and 1.7 on adherence, treatment completion and follow up. See also, recommendations on under served groups in section 1.2.3 on diagnosing latent TB in all age groups.

1.8.1 Strategic oversight and commissioning of TB prevention and control activities

1.8.1.1 Public Health England, in partnership with NHS England, should take responsibility for national oversight of TB prevention and control activities. This includes setting up TB control boards (see section 1.8.2). **[2012, amended 2016]**

1.8.1.2 Public Health England and NHS England should consider working together to establish control boards in agreed geographical areas and employ appropriate staff (see recommendation 1.8.2.3). **[new 2016]**

1.8.1.3 Clinical commissioning groups and local authority public health teams working in partnership with Public Health England and NHS England should consider collaborative commissioning arrangements through TB control boards. This could, for example, include working with 1 or more clinical commissioning groups to cover a major metropolitan district, region or TB control board area taking into account:

- local TB incidence
- local at-risk populations and their movements across different geographical areas
- existing service configurations for organisations involved in TB prevention and control
- the need to share services, such as mobile X-ray facilities, and outreach incident teams across different geographical areas. **[2012, amended 2016]**

1.8.1.4 TB control boards should develop TB prevention and control programmes working with commissioners, Public Health England and NHS England. The board could include clinical, commissioning (from clinical commissioning groups, local government and the voluntary sector) and public health leaders and people with TB or groups who advocate on their behalf from across the control board area. This may include identifying a lead clinical commissioning group, which could be led by an executive director of that commissioning group working with the board. Feedback mechanisms between local commissioning groups and the TB control board should be developed. **[new 2016]**

1.8.1.5 An executive director of local commissioning groups, working with the local director of public health or another nominated public health consultant, should lead implementation of the programme in their locality. The lead should ensure a comprehensive prevention and control programme is commissioned to support the level of need (see section on local needs assessment) and that they work with the control board regularly. **[2012, amended 2016]**

1.8.1.6 Working together through TB control boards and local networks, commissioners, local government and Public Health England should ensure TB prevention and control programmes set up multidisciplinary TB teams to provide all TB services (see section on commissioning multidisciplinary TB support). They should ensure that local strategy and service commissioning focuses on an end-to-end pathway. **[2012, amended 2016]**

1.8.1.7 Working together through TB control boards, commissioners and Public Health England should ensure the TB prevention and control programme is informed by relevant NICE guidance and developed in collaboration with clinical services. It should also be informed by the standard minimum data set collected through local needs assessment and service audit. **[2012, amended 2016]**

1.8.1.8 Working together through TB control boards, commissioners and Public Health England should ensure the TB prevention and control programme targets all ages, including children, and covers all aspects of TB prevention and control (see recommendations 1.8.2.1 and 1.8.2.2), including but not limited to:

- active case finding (contact investigations and identifying latent TB in high-risk groups)

- awareness-raising activities
- standard and enhanced case management (including providing directly observed therapy and free treatment)
- finding people lost to follow-up and encouraging them back into treatment
- incident and outbreak control
- monitoring, evaluating and gathering surveillance and outcome data. **[2012, amended 2016]**

1.8.1.9 Working together through TB control boards, commissioners, Public Health England and the voluntary sector should ensure TB prevention and control programmes take account of the need to work with other programmes targeting specific high-risk groups, such as those who are under-served. Examples include programmes focused on the health of asylum seekers and refugees, under-served children, homelessness and housing, offenders and people who misuse substances. **[2012, amended 2016]**

1.8.1.10 TB control boards should consider integrating TB and HIV services, joint clinics and training opportunities. **[new 2016]**

1.8.1.11 Commissioners should consider commissioning support and advice to all groups diagnosed with TB irrespective of whether they are under-served. **[new 2016]**

1.8.2 Developing the TB prevention and control programme

1.8.2.1 TB control boards should be responsible for developing a TB prevention and control programme based on the national strategy and evidence-based models. **[new 2016]**

1.8.2.2 TB control boards should plan, oversee, support and monitor local TB control, including clinical and public health services and workforce planning. **[new 2016]**

1.8.2.3 TB control boards should assess services in their area, identify gaps in provision and develop plans to meet these, including:

- undertaking a workforce review to support local or regional commissioning of TB services to meet the needs of their population (see sections on local needs assessment and cohort review)

- supporting development of appropriate services and pathways to improve access and early diagnosis (see the sections on rapid-access radiology and other investigation results: referral to multidisciplinary TB team process, non-clinical roles including TB support workers and rapid-access TB services)

- negotiating arrangements to cover the cost of additional services to address specific gaps in current TB control arrangements. **[new 2016]**

1.8.2.4 TB control boards should ensure cohort review is undertaken at least quarterly, and the results are fed back to local clinical and TB networks. These should be agreed by accountable bodies such as clinical commissioning groups, trust management, regional Public Health England and centre directors and local authority directors of public health as agreed, all of whom should make sure appropriate action is taken. **[new 2016]**

1.8.2.5 TB control boards should enable full and consistent use of national guidelines including:

- ensuring the needs of all people with TB, particularly under-served populations, are addressed

- ensuring contact tracing arrangements are appropriate to the needs of the population (see the section on case finding)

- assuring themselves that TB control in low-incidence areas is established and delivered appropriately (see the section on rural services: organisational and support factors)

- assuring themselves that multidrug-resistant TB is managed appropriately (see the section on multidrug-resistant TB) and mechanisms are in place to ensure:

  — there is sufficient clinical expertise available to manage cases

  — regional multidrug-resistant TB networks take account of expert advice

(see section 1.8.3). **[new 2016]**

1.8.2.6 TB control boards should develop links and partnerships and establish agreed relationships and lines of accountability between TB control boards and local clinical and TB networks. This includes engaging with other key stakeholders to ensure universal coverage of TB control efforts. **[new 2016]**

1.8.2.7 TB control boards should collaborate with their local and regional partners. They should agree and establish regular monitoring, surveillance and reporting arrangements with all partners to support needs assessment (see the section on local needs assessment) and regular audit and evaluation. **[new 2016]**

1.8.2.8 TB control board staff should have clearly defined roles and responsibilities. Their roles and responsibilities could include:

- Establishing the links, partnerships and relationships between all aspects of the control board area within their remit (if necessary across usual geographical commissioning boundaries).
- Developing and supporting adoption and implementation of evidence-based model service specifications for the clinical and public health actions needed to control TB including:
  - improving access and early diagnosis (see the sections on raising and sustaining awareness of TB, providing information for the public about TB, rapid-access radiology and other investigation results: referral to multidisciplinary TB team process and non-clinical roles including TB support workers)
  - diagnostics, treatment and care services (see the sections on latent TB and active TB)
  - contact investigations and tracing (see the sections on diagnosing latent TB in adults and case finding)
  - cohort review
  - vaccination (see the section on BCG vaccination)
  - drug resistance (see the section on multidrug-resistant TB)

- tackling TB in under-served populations
- surveillance, monitoring and quality assurance
- workforce development and commissioning (see the sections on commissioning multidisciplinary TB support and non-clinical roles including TB support workers). **[new 2016]**

1.8.2.9 TB control boards should ensure there is sufficient capacity available to them to manage a sudden increase in demand such as:

- TB contact investigations, (such as incidents in congregate settings)
- large scale active case-finding initiatives in under-served groups in the community
- outbreaks in a variety of settings or sites where transmission risk may be high, including but not limited to schools, workplaces, hostels and prisons. **[new 2016]**

1.8.2.10 To set up, monitor and evaluate a TB control programme, TB control boards should:

- agree plans within their partnerships to assess local services against the service specifications
- develop plans and quality standards to secure improvements
- establish quality assurance mechanisms and regular audits including, but not limited to, cohort review for all aspects of the TB control board partnership plans. **[new 2016]**

Coordinating local TB networks

1.8.2.11 TB control boards should (in collaboration with commissioners) consider the need for a TB network local coordinator, particularly if working across multiple clinical commissioning group areas (see recommendation 1.8.1.3). **[new 2016]**

1.8.2.12 The coordinator should work in close collaboration with clinicians and all relevant multidisciplinary TB teams to develop the network and be responsible for:

- setting up the network and developing it based on needs, reporting back to the TB control board regularly
- establishing the links, partnerships and relationships across their local network (if necessary across usual geographical commissioning boundaries). **[new 2016]**

1.8.3 Regional multidrug-resistant TB network

1.8.3.1 TB control boards should consider setting up a regional multidisciplinary TB network to oversee management of multidrug-resistant TB. This could:

- Identify and designate regional expert centres.
- Ensure all healthcare professionals who suspect or treat a case of multidrug-resistant TB are informed about and have access to specialist advisory services for multidrug-resistant TB. This includes the designated expert centre in their regional network and may also include the national advisory service for multidrug-resistant TB (currently provided by the British Thoracic Society).
- Ensure all cases of multidrug-resistant TB are discussed at the regional multidisciplinary TB team meeting in the local clinical network.
- Formally consider and record the advice from the specialist advisory services for multidrug-resistant TB provided by the designated regional expert centre or the national advisory service for multidrug-resistant TB. **[new 2016]**

1.8.4 Rural services: organisational and support factors

1.8.4.1 Commissioners in rural areas (working with the TB control board) should consider collaborative approaches to deliver and manage TB services. They could, for example, set up a network including areas with high and low incidence of TB. **[new 2016]**

1.8.5 Local needs assessment

1.8.5.1 Directors of public health, in discussion with local health protection teams, should ensure that TB is part of the joint strategic needs assessment. **[2012, amended 2016]**

1.8.5.2 Directors of public health should provide commissioners of TB prevention and control programmes and TB control boards with local needs assessment information annually using data provided by Public Health England. **[2012, amended 2016]**

1.8.5.3 Commissioners of TB prevention and control programmes should ensure services reflect the needs of their area, identified by needs assessment. Health and wellbeing boards should ensure that local TB services have been commissioned based on local needs identified through needs assessment. **[2012, amended 2016]**

1.8.5.4 Directors of public health and TB control boards should use cohort review (see section 1.8.6) and other methods to collect data on the following, to inform local needs assessment:

- Number of annual notified TB cases (see Public Health England's enhanced TB surveillance data and annual 'suite of indicators').
- Size, composition (for example, age and ethnicity) and distribution of local at-risk groups.
- Indices of social deprivation.
- Local statutory and non-statutory services working with these groups.
- Organisation of local TB services, including the composition and capacity of the local multidisciplinary TB team(see the results of local audit) and location of services. This may also include data to support evaluating the need for integrated TB/HIV services including joint clinics.
- Numbers needing enhanced case management (see the section on adherence, treatment completion and follow-up).
- Numbers receiving directly observed therapy from the start of, or at any point

during, treatment (see Public Health England's enhanced TB surveillance data).

- Evidence of recent transmission (for example, using DNA fingerprinting or surrogate markers such as number of cases in children under 5 years (see UK TB national strain-typing database and local incident and outbreak reports).
- Completeness and yield of contact investigations. This includes: proportion of smear-positive cases with 0, 5 or more contacts identified; proportion of identified contacts clinically assessed; and proportion of contacts with latent TB infection who successfully complete treatment.
- Active case-finding initiatives, incident contact investigations and identification of latent TB infection in high-risk groups.
- Treatment outcomes for everyone grouped according to social risk factors and by the use of directly observed therapy (including rates of loss to follow-up and treatment interruptions, see Public Health England's enhanced TB surveillance data).
- Local education and awareness-raising programmes for under-served groups, professionals and practitioners working with them.
- Views and experiences of people with TB, carers and the services working with them. **[2012, amended 2016]**

1.8.5.5 Local needs assessments should also be equity proofed to assess the potential effect of planning, commissioning and policy decisions on health inequalities (see planning and commissioning services in NICE's local government briefing on health inequalities and population health). **[new 2016]**

1.8.6 Cohort review

1.8.6.1 TB control boards and prevention and control programme leads should initiate, audit and evaluate cohort reviews in their commissioning area. Quarterly cohort review meetings should take place in the area covered by the programme. Combine these meetings with others if possible, or use technology to make it easier for clinicians and case managers to attend. **[2012, amended 2016]**

1.8.6.2 TB case managers should present standardised information on each case, including: demographic information, HIV test results, pre-treatment and ongoing status (clinical, laboratory, radiology), adherence to treatment and the results of contact investigations. **[2012, amended 2016]**

1.8.6.3 TB case managers and key allied professionals from the TB prevention and control programme should attend cohort review meetings. This could include the lead clinician (who may or may not be the case manager). Either a paediatrician with experience and training in the treatment of TB or a general paediatrician with advice from a specialised clinician should be present when cases of children with TB are presented. **[2012, amended 2016]**

1.8.6.4 The chair of the cohort review should not work for any of the TB services included in the review. Examples of possible chairs include a public health consultant, a specialist physician or a senior TB nurse, preferably from a different geographical area. Alternatively the chair could be a representative from the local Public Health England health protection team or the TB control board. **[2012, amended 2016]**

1.8.6.5 Multidisciplinary TB teams, in conjunction with Public Health England units, should collate and present cohort review data on TB treatment and the outcome of contact investigations at the review meetings. In addition, progress towards national, regional and local service targets should be presented. **[2012, amended 2016]**

1.8.6.6 TB control boards, directors of public health and local public health consultants should ensure outputs from the cohort review feed into the needs assessment for TB services. TB control board directors should attend the cohort review at least once a year. **[2012, amended 2016]**

1.8.6.7 TB case managers should feed back promptly to multidisciplinary TB teams on issues identified as a result of cohort review. The results of the cohort review should be collated locally and agreed by the chair before being fed back to TB control boards, commissioners and health and wellbeing boards regularly and via needs assessment. **[2012, amended 2016]**

1.8.6.8 People participating in a cohort review should review the results and evaluate

local services (for example, auditing adverse outcomes, rates of culture confirmation, treatment completion rates or time to diagnosis). **[2012, amended 2016]**

1.8.7 Commissioning multidisciplinary TB support

1.8.7.1 Commissioners should ensure multidisciplinary TB teams:

- Have the skills and resources to manage the care of people with active TB who are not from under-served groups. **[2012, amended 2016]**
- Include at least 1 TB case manager with responsibility for planning and coordinating the care of under-served people and those with active TB who receive enhanced case management. **[2012, amended 2016]**
- Have the resources to manage latent TB care in under-served groups and the wider population. **[new 2016]**
- Include a range of clinical specialties in the multidisciplinary TB team, including paediatrics, infection control and respiratory medicine. **[2012]**
- Have regular attendance at these multidisciplinary team and cohort review meetings for all team members included as a programmed activity as part of their work planning. **[new 2016]**
- Have the skills and resources necessary to manage the care of people with complex social and clinical needs (either directly or via an established route). This includes the ability to provide prompt access (or if necessary, referral) to skilled outreach and advocacy workers who can draw on the services of allied practitioners. The aim is to address people's housing, asylum, immigration, welfare, substance dependency and other health and social care needs. (The allied practitioner support should include both a specified housing officer and a social worker.) **[2012]**
- Can provide rapid access TB clinics for all cases, including under-served groups. **[2012]**
- Consider providing administration support for TB nurses and case managers so they have capacity for clinical and case management work. This could

include giving TB nurses access to computer hardware and software. **[new 2016]**

- Have the resources to provide a continuous service throughout the year, ensuring the TB service accounts for the following to manage continuity of care:
  - planned absence (for example, professional development, mandatory training, annual, maternity or paternity leave)
  - unplanned absence (such as sickness absence). **[2012, amended 2016]**
- Can provide prompt access to a professional who has training and experience in assessing and protecting children and vulnerable adults at risk of abuse or neglect. **[2012]**
- Have access to funds through local government and clinical commissioning groups that can be used flexibly to improve adherence to treatment among under-served groups. For example, funds could be used to provide transport to clinics, to provide support or enablers for treatment, or for paying outreach workers or community services to support directly observed therapy. Funds may also be used to provide accommodation during treatment. **[2012, amended 2016]**
- Have the resources to provide ongoing TB awareness-raising activities for professional, community and voluntary (including advocacy) groups that work with populations at high risk of TB (see the section on raising and sustaining awareness of TB). These resources could be financed by local government or clinical commissioning groups. **[2012, amended 2016]**

1.8.7.2 Commissioners should ensure NHS England's safe staffing principles are applied when commissioning TB services.

The staffing ratios used in Public Health England and NHS England's collaborative tuberculosis strategy for England (published in 2015) came from NICE's guideline on tuberculosis: identification and management in under-served groups (published in 2012) which has been replaced by this guideline.

NICE's 2012 guideline on tuberculosis: identification and management in under-

served groups recommended 1 WTE case manager per 40 incident cases needing standard management and 1 WTE case manager per 20 incident cases needing enhanced case management. **[new 2016]**

1.8.8 Non-clinical roles including TB support workers

1.8.8.1 TB control boards and local TB services should consider employing trained, non-clinically qualified professionals to work alongside clinical teams to agreed protocols, and to contribute to a variety of activities. Examples of this may include awareness raising and supporting people to attend appointments (including other health and social care appointments). They could also help with collecting samples, contact tracing, case management including directly observed therapy and cohort review, or any other aspect of the service if:

- they are trained to deliver the intervention or processes effectively
- they are supported, mentored and supervised by a named case manager, such as a TB nurse
- they have the skills to monitor, evaluate and report on their work practices and outcomes to maintain a process of ongoing evaluation and service improvement in relation to cohort review (see the section on cohort review). **[new 2016]**

1.8.8.2 TB control boards should ensure that people working in the TB service have the right knowledge, engagement, advocacy and communication skills to meet the needs (for example, language, cultural or other requirements) of all the groups they may work with. **[new 2016]**

1.8.8.3 Commissioners should consider taking into account different needs across traditional geographical and organisational boundaries. Put agreements in place so that staff can work across these boundaries, covering the whole service or TB control board area if appropriate. **[new 2016]**

1.8.8.4 Commissioners and TB control boards should ensure they put in place appropriate governance (including clear lines of accountability and extension of scope of practice) and data sharing practices and agreements. This includes

ensuring they are part of service level agreements between NHS and non-NHS services, for example, the third sector or local government, and appropriate training has been completed. **[new 2016]**

1.8.9 Rapid-access TB services

1.8.9.1 Multidisciplinary TB teams should establish relationships with statutory, community and voluntary organisations that work with people at risk of TB to develop appropriate TB referral pathways. They should ensure these organisations know how to refer people to local TB services. **[2012]**

1.8.9.2 Multidisciplinary TB teams should accept referrals from healthcare providers and allied organisations working in the community with under-served groups. This includes voluntary and statutory organisations (for example, mobile X-ray teams or community organisations or outreach workers working with vulnerable migrants). **[2012]**

1.8.9.3 Multidisciplinary TB teams should accept self-referrals to TB clinics by people who suspect they have TB or have recently been in contact with someone with TB. **[2012, amended 2016]**

1.8.9.4 Multidisciplinary TB teams should consider accepting direct referrals from emergency departments (see the section on rapid-access radiology and other investigation results: referral to multidisciplinary TB team process). **[new 2016]**

1.8.9.5 Healthcare professionals should consider urgent referral to TB clinics for people with suspected active TB. They should also ensure the results from first-line diagnostic tests (including a sputum smear and chest X-ray) are available before the person sees a specialist. (Note: this should not delay the referral.) **[2012, amended 2016]**

1.8.9.6 Multidisciplinary TB teams should have pathways to triage referrals, start investigations and collect clinical information before the person is seen by a physician. **[new 2016]**

1.8.9.7 While triaging, multidisciplinary TB teams should ensure everyone is given

information about TB as part of the process (see the section on providing information for the public about TB). This should include who the person should contact if they have any questions and how to access advice or information from support groups, national charities such as TB Alert and other sources such as local government (for example, public health or social care teams). **[2016]**

1.8.9.8 Multidisciplinary TB teams should ensure people who have a smear-positive result or imaging features highly suggestive of smear-positive TB (for example, evidence of cavitation on chest X-ray) are assessed the next working day. This is so that case management and infection control procedures start promptly. **[2012, amended 2016]**

1.8.9.9 The multidisciplinary TB team should assess people who are not smear-positive but have imaging that suggests pulmonary or laryngeal TB as soon as possible. This should be no later than 5 working days after a referral. **[2012, amended 2016]**

1.8.9.10 Multidisciplinary TB teams should, where necessary, be able to provide or arrange outreach services to ensure sputum samples or other assessments such as contact investigations can be arranged in the community. **[2016]**

1.8.10 Identifying and managing active TB in prisons, custody suites or immigration removal centres: organisational factors

1.8.10.1 Multidisciplinary TB teams, prisons, custody suites and immigration removal centre healthcare services should have named TB liaison leads to ensure they can communicate effectively with each other. **[2012, amended 2016]**

1.8.10.2 Prison, custody suites and immigration removal centre healthcare services should develop a TB policy by working with the TB control board and multidisciplinary TB team and the local Public Health England health protection team. **[2012, amended 2016]**

1.8.10.3 Multidisciplinary TB teams, in conjunction with prisons, custody suites and immigration removal centre healthcare services, should agree a care pathway for TB. This is to ensure that any suspected or confirmed cases are reported to, and

managed by, the multidisciplinary TB team. **[2012, amended 2016]**

1.8.10.4 Multidisciplinary TB teams, in liaison with prisons, custody suites or immigration removal centre healthcare providers, should manage all cases of active TB. Investigations and follow-up should be undertaken within the prison or immigration removal centre if possible. **[2012, amended 2016]**

1.8.11 Accommodation during treatment

1.8.11.1 Multidisciplinary TB teams should assess the living circumstances of people with TB. Where there is a housing need they should work with allied agencies to ensure that all those who are entitled to state-funded accommodation receive it as early as possible during their treatment, for example, as a result of a statutory homelessness review and identified need. **[2012, amended 2016]**

1.8.11.2 Multidisciplinary TB teams, commissioners, local authority housing lead officers and other social landlords, providers of hostel accommodation, hospital discharge teams, Public Health England and the Local Government Association should work together to agree a process for identifying and providing accommodation for homeless people diagnosed with active pulmonary TB who are otherwise ineligible for state-funded accommodation. This includes people who are not sleeping rough but do not have access to housing or recourse to public funds. The process should detail the person's eligibility and ensure they are given accommodation for the duration of their TB treatment. **[2012, amended 2016]**

1.8.11.3 Local government and clinical commissioning groups should fund accommodation for homeless people diagnosed with active TB who are otherwise ineligible for state-funded accommodation. Use health and public health resources, in line with the Care Act 2014. **[2012, amended 2016]**

1.8.11.4 Multidisciplinary TB teams should make people who would not otherwise be entitled to state-funded accommodation aware that they may lose this accommodation if they do not comply with treatment. They should ensure plans are made to continue housing people once their TB treatment is completed. **[2012]**

1.8.11.5 Public Health England, working with the Local Government Association and their special interest groups, should consider working with national housing organisations such as the Chartered Institute of Housing, Homeless Link, Sitra and the National Housing Federation to raise the profile of TB. This is to ensure people with TB are considered a priority for housing. **[new 2016]**

1.8.11.6 Consider training housing commissioners and frontline staff on TB and the need for housing support, so that they understand that a stable home life is a prerequisite to successful TB treatment. **[new 2016]**

Terms used in this guideline

Active case-finding

Systematically identifying people with active or latent TB using tests, examinations or other procedures.

Adherence

The term adherence refers to the person's ability or willingness to keep to a treatment regimen as directed.

Adults

People aged 18 or older.

Case management

Case management involves follow-up of a person suspected or confirmed to have TB. It needs a collaborative, multidisciplinary approach and should start as soon as possible after a suspected case is discovered.

Case manager

Standard and enhanced case management is overseen by a case manager who will usually be a specialist TB nurse or (in low-incidence areas) a nurse with responsibilities that

include TB. Depending on the person's circumstances and needs, case management can also be provided by appropriately trained and supported non-clinical members of the TB multidisciplinary team.

Children

People aged 15 or younger.

Children and young people

People aged 17 or younger.

Close contacts

'Close contacts' are people who have had prolonged, frequent or intense contact with a person with infectious TB. For example, these could include 'household contacts', those who share a bedroom, kitchen, bathroom or sitting room with the index case. Close contacts may also include boyfriends or girlfriends and frequent visitors to the home of the index case. Depending in the circumstances, occasionally coworkers are classed as 'close contacts although they are more usually classed as 'social contacts'.

Cohort review

Cohort review is a systematic quarterly audit of the management and treatment of all TB patients and their contacts. The 'cohort' is a group of cases counted over a specific time, usually 3 months. Brief details of the management and outcomes of each case are reviewed in a group setting. The case manager presents the cases they are responsible for, giving the opportunity to discuss problems and difficulties in case management, service strengths and weaknesses, and staff training needs.

Congregate setting

A place where people congregate or an institutional setting such as a workplace, prison, hostel, or childcare or educational setting, where social contacts might have had significant exposure to TB.

Contact

A person who has spent time with someone with infectious TB. See also 'close contact' and 'social contact'.

Contact investigation

Clinical investigations (diagnostic testing) of people identified as having had significant exposure to a case of TB, including tests to diagnose latent or active TB. The aims of contact investigations are to:

- detect active TB earlier to offer treatment and prevent further transmission
- detect latent TB that may benefit from drug treatment
- detect people not infected but for whom BCG vaccination might be appropriate.

Contact tracing

Identifying people who may have come into contact with a person with infectious TB and assessing them for risk of significant exposure to TB. The aim is to find associated cases, to detect people with latent TB and to identify those not infected but for whom BCG vaccination might be appropriate.

Disseminated TB

Blood-borne spread of TB that may or may not be accompanied by chest X-ray or high resolution CT changes.

Enablers

Methods of helping someone to overcome barriers to completing diagnostic investigations and TB treatment. Examples of barriers include: transport, housing, nutrition and immigration status.

Enhanced case management

Management of TB for someone with clinically or socially complex needs. It starts as soon

as TB is suspected. As part of enhanced case management, the need for directly observed treatment is considered, along with a package of supportive care tailored to the person's needs.

Equity proofed

Tools such as health equity audit and health impact assessment have been used systematically to assess the potential effect of all policies, programmes and activities (including those without an explicit health focus) on health inequalities. Equity proofing helps ensure all policies and programmes address the social determinants of health and health inequalities. Including a health equity audit as part of the joint strategic needs assessment can help local authorities and their partners to:

- develop strategy and plans according to need
- identify and work with community and health partners
- commission activities based on the best available evidence
- implement interventions to tackle inequity.

End-to-end pathway

The pathway from awareness raising and primary prevention, through diagnosis to treatment completion, incorporating all aspects such as contact tracing and other infection control mechanisms, for example, access to isolation facilities. This includes governance and commissioning considerations so that a comprehensive clinical and public health service is developed and delivered across any agreed geographical footprint.

Extrapulmonary TB

Active TB disease in any site other than the lungs or tracheobronchial tree.

Extensively drug-resistant TB

Resistance to at least isoniazid and rifampicin, 1 injectable agent (capreomycin, kanamycin or amikacin) and 1 fluoroquinolone.

High incidence

A high-incidence country or area has more than 40 cases of TB per 100,000 people per year. Public Health England lists high-incidence countries and areas of the UK on its website.

High-risk groups

The term 'high-risk groups' is used in this guideline to mean adults, young people and children from any ethnic background, regardless of migration status, who are at increased risk of having or contracting TB. This includes people classified as under-served, people identified as contacts according to the case finding recommendations, new entrants from high-incidence countries and people who are immunocompromised.

Homelessness

For the purposes of TB control, a broad and inclusive definition of homelessness has been adopted that incorporates overcrowded and substandard accommodation. It includes people:

- who share an enclosed air space with people at high risk of undetected active pulmonary TB (that is, people with a history of rough sleeping, hostel residence or substance misuse)
- without the means to securely store prescribed medication
- without private space in which to self-administer TB treatment
- without secure accommodation in which to rest and recuperate in safety and dignity for the full duration of planned treatment.

Immigration removal centres

Immigration removal centres are private or prison-run holding centres for migrants waiting to be accepted by, or deported from, the UK. Immigration removal centres are also known as immigration detention centres and pre-departure accommodation.

Immunocompromised

In this guideline, immunocompromised refers to a person who has a significantly impaired immune system. For instance, this may be because of prolonged corticosteroid use, tumour necrosis factor-alpha antagonists, antirejection therapy, immunosuppression-causing medication or comorbid states that affect the immune system, for example, HIV, chronic renal disease, many haematological and solid cancers, and diabetes.

Incident risk assessment

Assessment of risk of exposure to TB in a congregate setting to decide on the need for and extent of contact investigation. The risk assessment would take into consideration factors such as infectiousness of the index case, vulnerability of contacts to TB infection, length of contact with or exposure to an infectious case and the built environment (for example, size of the rooms, ventilation and overcrowding).

Index case

The initial person found to have TB, whose contacts are screened. The source of their infection may be found to be 1 of the contacts, but the person who presents first is regarded as the index case.

Induration

The firm skin reaction occurring after a tuberculin skin test to diagnose latent TB infection. It is measured, and the result used to determine whether the test result is classified as positive or negative. This guideline recommends a threshold of 5 mm for tuberculin skin test positivity.

Infectious TB

Active smear-positive pulmonary TB, that is with acid fast bacilli visible on microscopy. Active TB affecting other parts of the respiratory tract or oral cavity, though rare, is also considered infectious.

Isolation

An infection control measure in which people with infectious TB are kept away from others who may be at risk of infection. This guideline deals with 3 levels of isolation for infection control in hospital settings:

- negative pressure rooms, which have air pressure continuously or automatically measured, as defined by NHS Property Services
- single rooms that are not negative pressure but are vented to the outside of the building
- beds on a ward, for which no particular engineering standards are needed.

Lost to follow-up

People are defined as 'lost to follow-up' if they cannot be contacted within 10 working days of:

- their first missed outpatient appointment (if they are on self-administered treatment)
- their first missed directly observed therapy appointment (if they are on directly observed therapy).

Multidisciplinary TB teams

A team of professionals with a mix of skills to meet the needs of someone with TB who also has complex physical and psychosocial issues (that is, someone who is under-served). Team members will include a social worker, voluntary sector and local housing representatives, TB lead physician and nurse, a case manager, a pharmacist, an infectious disease doctor or consultant in communicable disease control or health protection, a peer supporter or advocate and a psychiatrist.

Multidrug-resistant TB

TB resistant to isoniazid and rifampicin, with or without any other resistance.

Negative pressure room

Used to isolate some patients known or suspected to have infectious TB. A negative pressure room is one where the air from the room is sucked out into dedicated ducting through a filter and into the outside air, at a distance from all other air intakes. The pressure should be 10 pascals below the ambient air pressure.

Neonates

Children aged 4 weeks or younger.

New entrant

Anyone coming to work or settle in the UK. This includes immigrants, refugees, asylum seekers, students and people on work permits. It also includes UK-born people, or UK citizens, re-entering the country after a prolonged stay in a high-incidence country.

Opportunistic case-finding

Opportunistic identification of people with active or latent TB using tests, examinations or other procedures in the course of existing appointments or interactions, rather than identification through formal screening programmes.

Outbreak

There is no robust, widely accepted threshold for an outbreak of a disease, but in practical terms an outbreak is the occurrence of an unusually high number of cases in associated people, in a small geographical area, or in a relatively short period of time.

Peers

Peers are people who may have experienced TB. They are often in a good position to help convey, with empathy, the need for testing or treatment. They may be recruited from specific populations. With support they can communicate health messages, assist with contact investigations or testing and offer people support while they are being tested or treated.

Prisons

Any state prison establishments, including young offender institutions.

Rapid access

In the context of TB services, rapid access refers to timely support from a specialist team.

Smear grade

The number of bacilli found in a sputum sample, believed to relate to the degree of infectivity of the person. There are several systems but in general recording goes from no mycobacteria in 100 fields (0 or negative) to more than 10 acid-fast bacilli per field in at least 20 fields (grade 3).

Social contacts

Someone who has had contact with a person with infectious TB but has not been in prolonged, frequent or intense contact.

Substance misuse

Substance misuse is defined as intoxication by, or regular excessive consumption of or dependence on, psychoactive substances, leading to social, psychological, physical or legal problems. It includes problematic use of both legal and illegal drugs.

TB control board

A partnership of mixed professionals and lay people who have experience of leading, commissioning, managing or supporting people with TB. Board members are likely to include the voluntary sector, housing representatives, TB specialists and other clinicians, consultants in communicable disease control or health protection, peer supporter and advocate groups, clinical commissioning groups, executive officers, local government commissioners and an independent chair. This list is not intended to be exhaustive; membership should be determined based on an area's needs, agreements and commissioning arrangements.

Treatment interruption

A break in the prescribed anti-TB regimen for 2 weeks or more in the initial phase, or more than 20% of prescribed doses missed intermittently.

Under-served groups

This term is used in this guideline to mean groups of adults, young people and children from any ethnic background, regardless of migration status. They are 'under-served' if their social circumstances, language, culture or lifestyle (or those of their parents or carers) make it difficult to:

- recognise the clinical onset of TB
- access diagnostic and treatment services
- self-administer treatment (or, in the case of children and young people, have treatment administered by a parent or carer)
- attend regular appointments for clinical follow-up.

The groups classified as under-served in this guideline are:

- people who are homeless
- people who misuse substances
- prisoners
- vulnerable migrants.

Under-served children

Groups of children identified as potentially under served include:

- unaccompanied minors
- children whose parents are under served, including vulnerable migrants
- children whose parents are in prison or who abuse substances

- children from Gypsy and Traveller communities
- looked-after children.

Vulnerable migrants

Vulnerable migrants may include undocumented migrants and those with no recourse to public funds. Some refugees, asylum seekers and new entrants to the country may also fall into this category.

Young people

People aged 16 or 17.

Context

Tuberculosis (TB) is a curable infectious disease caused by a type of bacterium called *Mycobacterium tuberculosis* ('M. tuberculosis' or 'M.Tb'), or other bacterium in the M. tuberculosis complex (that is*, M. bovis* or *M. africanum*). It is spread by droplets containing the bacteria being coughed out by someone with infectious TB, and then being inhaled by other people.

The initial infection clears in over 80% of people but, in a few cases, a defensive barrier is built round the infection and the TB bacteria lie dormant. This is called latent TB; the person is not ill and is not infectious. If the immune system fails to build the defensive barrier, or the barrier fails later, latent TB can spread in the lung (pulmonary TB) or develop in the other parts of the body it has spread to (extrapulmonary TB). Only a small proportion of people with latent TB will develop symptoms ('active TB').

Many cases of TB can be prevented by public health measures and, when clinical disease does occur, most people can be cured if treated properly. Taking medication in the wrong dose or combination, irregularly or for too short a time can lead to drug resistance. Drug-resistant strains of TB are much harder to treat and significantly increase a person's risk of long-term complications or death. If left untreated, 1 person with active pulmonary TB may infect as many as 10 to 15 people every year.

TB incidence in the UK has increased since the early 1990s, but has remained relatively stable since 2005. Despite this, it remains high compared with many other western European countries. Cases tend to cluster in urban areas where populations of at-risk groups are high. These include areas with many people born in countries with a high incidence of TB, areas with a high level of homelessness, poor housing or poverty, and areas with high rates of problem drug use.

The NHS and Public Health England, as well as a local authority public health teams and many third sector organisations, have been working to reduce the harm caused by TB to many individuals and communities. TB is a notifiable disease, meaning that clinicians have a statutory duty to notify local authorities or a local Public Health England centre of suspected cases, and efforts have been made to strengthen services and ensure clear lines of accountability and responsibility. However, a stronger approach to TB control is now needed to build on this work. Indicators of TB incidence and TB treatment outcomes have been included in the Public Health Outcomes Framework. In addition, Public Health

England and NHS England have designed a collaborative tuberculosis strategy for England that brings together best practice in clinical care, social support and public health. Agencies at all levels, including national and local government, clinical commissioning groups and third sector partners, are committed to working in partnership to decrease the incidence of TB, fight the spread of drug-resistant forms of the disease, reduce current health inequality and, ultimately, eliminate TB as a public health problem in England.

Recommendations for research

The guideline committee has made the following recommendations for research. The guideline committee's full set of research recommendations is detailed in the full guideline.

1 Universal compared with risk-based approach to using rapid diagnostic tests

In people with suspected TB, what is the relative clinical and cost effectiveness of universal and risk-based use of rapid nucleic acid amplification tests?

Why this is important

The guideline committee noted that there were 2 possible approaches to using rapid nucleic acid amplification tests for suspected TB. The current approach is to use them only if TB is strongly suspected and rapid information about mycobacterial species would alter the person's care. Another approach is to use them in anyone with a possible diagnosis of TB. There is a trade-off between ensuring that all people with active TB are diagnosed and avoiding a large number of false positives, which leads to unnecessary treatment. This trade-off may lead to differences in the cost effectiveness of each approach. NICE's systematic review of the diagnosis of active TB did not identify any robust evidence on this, nor did the health technology assessment on using nucleic acid amplification tests to detect drug resistance. Cost-effectiveness studies are needed to improve understanding in this area.

2 Diagnosis in children

Apart from culture, what other diagnostic tests or combinations of tests are effective in establishing an accurate diagnosis of active respiratory TB in children and young people with suspected active TB?

Why this is important

The guideline committee noted the lack of evidence on the diagnosis of active TB in children. The disease manifests differently in children than in adults, and more evidence

would have been useful to the committee. Cross-sectional studies are needed to examine the relative accuracy of different tests, and the most appropriate specimen type for these tests, compared with tests currently in use. In particular, the poor accuracy of many tests in children means that diagnostic strategies that is, combinations of tests, should be investigated, including both tests with high sensitivity and tests based on host response.

3 Treating isoniazid-resistant TB

For isoniazid-resistant TB, what is the most effective regimen for reducing mortality and morbidity?

Why this is important

There is little evidence for the treatment of isoniazid resistant TB. This is the most common form of drug resistance in the UK, occurring in 7.5% of TB cases. Currently, treatment is not always successful, even when the recommended drugs are given for the recommended time and there are no adherence issues. It is particularly difficult to treat if there are treatment interruptions or if the central nervous system is involved. Randomised controlled trials are needed to compare different anti-TB regimens for isoniazid-resistant TB, assessing mortality, treatment success or treatment failure, rates of relapse and adverse events.

4 Impact of infection control measures on quality of life

What effects does isolation have on the quality of life of people being treated for TB?

Why this is important

Isolation is known to significantly affect a person's quality of life. Despite this, the guideline committee identified no reliable data on the impact of isolation on quality of life. This information is essential in producing economic models that reflect the real costs of isolation. Data on the impact of isolation on quality of life need to be collected and reported.

5 Treatment interruptions caused by adverse

events (specifically hepatotoxicity)

For people with active, drug susceptible TB who experience treatment interruptions because of adverse events, particularly hepatotoxicity, what approach to re-establishing treatment is most effective in reducing mortality and morbidity?

Why this is important

There is little evidence on re-establishing treatment after interruptions because of adverse events. This is key to ensuring treatment success without relapse or the emergence of drug resistance, but avoiding further adverse events is also important. Randomised controlled trials are needed to compare approaches to re-establishing treatment for active, drug susceptible TB after it is interrupted because of adverse events, particularly hepatotoxicity. These trials should assess mortality, treatment success or failure, rates of relapse, the recurrence of adverse events and the emergence of drug resistance. Approaches evaluated could compare, for example, restarting regimens with lengthening their duration, as well as sequential reintroduction. Approaches should vary depending on the proportion of doses missed and the stage of treatment (initial or continuation phase) in which the interruption occurred. Prospective observational cohort studies with multivariable analyses may also be useful.

Finding more information and committee details

To find NICE guidance on related topics, including guidance in development, see the NICE topic pages on tuberculosis and vulnerable groups.

For full details of the evidence and the guideline committee's discussions, see the full guideline. You can also find information about how the guideline was developed, including details of the committee.

NICE has produced tools and resources to help you put this guideline into practice. For general help and advice on putting our guidelines into practice, see resources to help you put NICE guidance into practice.

Update information

February 2024: We removed the final bullet of recommendation 1.1.3.10, which said 'have a family history of TB in the past 5 years', to align it with the chapter on tuberculosis in the Green Book.

September 2019: Minor wording changes have been made to recommendation 1.7.4.2 and footnotes added to reflect new restrictions and precautions for the use of fluoroquinolone antibiotics. It is labelled **[new 2016, amended 2019]**.

June 2019: Recommendation 1.6.1.8 has been amended to add in more detail about the meaning of contacts.

November 2018: Recommendation 1.1.3.16 on BCG vaccinations for healthcare workers and other NHS employees was updated after a surveillance review.

May 2016: Recommendation 1.2.1.1 was clarified to reflect the sequencing of tests. Reference to IGRA status was removed from recommendations 1.1.3.13; 1.1.3.16-18; 1.1.4.6; 1.1.4.8 and 1.6.1.4.

February 2016: Recommendation 1.1.3.4 has been amended to clarify that the recommendation is about assessing risk for and vaccinating the baby.

January 2016: This guideline was published. It is an update of NICE guideline CG117 (published March 2011) and replaces it. It also incorporates and adapts NICE guideline PH37 (published March 2012).

Through the scoping process we work with stakeholders to identify, prioritise and agree areas of the guideline to update. This means that areas outside the scope were not reviewed during this update and the recommendations may not reflect current practice. Areas that have not been reviewed in this update may be addressed 2 years after publication, when NICE next considers updating this guideline. NICE may undertake an update of discrete areas of the guideline if new and relevant evidence is published.

Recommendations are marked as:

- **[new 2016]** if the evidence has been reviewed and the recommendation has been

added or updated

- **[2016]** if the evidence has been reviewed but no change has been made to the recommended action
- **[2006]** if the evidence has not been reviewed since 2006
- **[2006, amended 2011]** or **[2011]** if the evidence has not been reviewed since 2006
- **[2012]** if the evidence has not been reviewed since 2012
- **[2006, amended 2011, amended 2016]** or **[2011, amended 2016]** if the evidence has not been reviewed since 2011, but either changes have been made to the recommendation wording that change the meaning or NICE has made editorial changes to the original wording to clarify the action to be taken (see below).
- **[2006, 2012, amended 2016]** or **[2012, amended 2016]** if the evidence has not been reviewed since 2012, but either changes have been made to the recommendation wording that change the meaning or NICE has made editorial changes to the original wording to clarify the action to be taken (see below).

Recommendations from NICE guideline CG117 that have been amended

Recommendations are labelled **[2011, amended 2016] and [2006, amended 2011, amended 2016]** if the evidence has not been reviewed but either:

- changes have been made to the recommendation wording that change the meaning, or
- NICE has made editorial changes to the original wording to clarify the action to be taken.

Further details of the specific changes to the recommendations during the 2016 update are available on request.

Recommendations from NICE guideline PH37 that have been amended

Recommendations are labelled **[2012, amended 2016]** if:

- The evidence has not been reviewed, but a change has been made to clarify roles or actions in the original recommendation, extrapolate to the whole population, or where

system changes such as establishment of TB control boards have been reflected

- NICE has made editorial changes to the wording to clarify the action to be taken, but where there is no change of meaning to the original recommendation.

Further details of the specific changes to the recommendations during the 2016 update are available on request.

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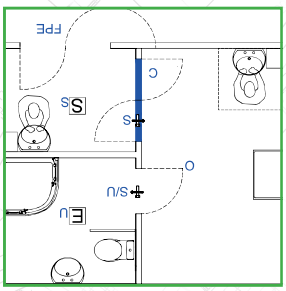
Accreditation

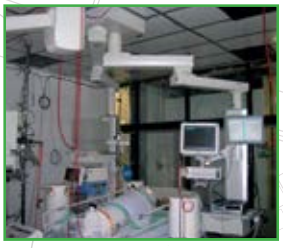
BSRIA

BTS 3/2018

Air Permeability Testing of Isolation Facilities

By Tom Jones and Blanca Beato Arribas





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Contents

Appendices

Glossary of terms

Room/suite envelope
The boundary or barrier separating the inside of the room/suite subject to the test from the outside environment or another part of the building. Where the element relied upon for sealing the room is a dropped ceiling, this should be taken as the limit of the envelope. Where the element relied upon for sealing the room is the building's structural slab, this should be taken as the limit of the envelope.

Air permeability
The air leakage rate per envelope area across the room/suite envelope at a reference pressure difference, as defined within ATTMA TSL2[1]. Air permeability is measured in $m^3/(h.m^2)$@50 Pa. It is obtained by dividing the air leakage in m^3/h at a reference pressure of 50 Pa by the envelope area of the room/suite in m^2, including walls, floor and ceiling.

Specific leakage rate
Air leakage rate across the room/suite envelope or an element such as a door at a specific pressure difference such as the operating pressure of the room/suite

To seal an opening
To make an opening hermetic by any appropriate means, such as board and tape

FPE
Fan pressurisation equipment

Patient's room
The isolation room where the bed is located

Isolation suite
The space containing the patient's room, entrance lobby, en-suite facilities and possibly other rooms such as an instrument room and an exit lobby

Operating pressure
The differential pressure specified by the client for the room or element in question

Disclaimer

An isolation suite designed to contain an airborne infection (or to protect a patient from an airborne infection), when subjected to pressure differentials, will have some leakage through its envelope or through its components (for example through door gaps). Minimising the air leakage of an isolation suite will minimise the amount of cross contamination between the inside and the outside of the isolation suite. The tests described in this standard and the air leakage limits used do not guarantee that airborne infection will not occur.

1 Introduction

An isolation suite can be formed of several adjacent rooms, including an entrance lobby, the patient's room and en-suite facilities and, on some occasions, other rooms such as an exit lobby and an instrument room.

Air leakage in isolation suites needs to be minimised to reduce the risk of infection. Air leakage to or from an isolation suite translates into unaccounted-for airborne pathogens travelling from or to other hospital areas.

The design of the isolation suite should take into account the airflows through the doors, grilles, pressure stabilisers, supply and extract grilles and other components and the air leakage through the envelope. The sum of flows into and out of every room (including leakage through the envelope) should be zero. It is important to make sure that all possible air flow paths have been considered.

The successful operation of an isolation suite requires the air permeability to be within its required criterion and the airflow through known air leakage paths to be within defined limits.

Reducing the air permeability of an isolation suite has a number of distinct benefits:

- A degree of passive protection is provided against contamination to or from adjacent areas.
- The ventilation system is able to be balanced and commissioned correctly.
- The pressure stabiliser can be specified accurately and can operate correctly.
- During fumigation, less fumigant will escape to adjacent areas.
- In the event of fan failure, the walls will become the first barrier against infection.
- If the leakage through the fabric is too high, the design supply and extract airflow rates may not be sufficient to pressurise the rooms or for the pressure stabiliser to operate correctly. Making up for high air permeability by increasing supply and extract flow rates is not considered desirable. A better option would be to achieve lower air permeability.

Introduction

This standard recommends limits for the overall air leakage of the isolation suite (including the entrance lobby, the patient's room and the en-suite) and also gives recommendations on how to measure air leakage through paths such as doors and door grilles, allowing for comparison against the design specifications. The airflow through these components is an integral part of the ventilation strategy and therefore has to be included within the measured air leakage of the room.

Since every isolation suite is different, specific examples of testing the air permeability of two types of isolation suites have been described in Section 4. These are the same two types of isolation suite described in HBN-04-01 Supplement 1[3].

BSRIA recommends that testing is undertaken at intervals not exceeding 14 months. If any works are carried out that might affect the envelope of the isolation suite, the test should be repeated. Testing should not be carried out if doing so would compromise patient safety in any way.

2 Specifications

The air permeability should be specified at design stage.

The superseded 2005 edition of HBN 4 Supplement 1[2] stated that "The suite will be considered fit for purpose if at a test pressure of +20 and -20 Pascals it has an average leakage rate of not more than 1 l/s of air per m^3 of envelope volume."

BSRIA suggests a maximum air permeability of 2.5 $m^3/(h.m^2)$@50Pa for isolation suites and all individual rooms.

For each room/suite tested, both a pressurisation and a depressurisation test should be carried out. Both results should be below the recommended limits.

If the specified air permeability limits cannot be achieved, remedial work should be carried out, for example additional sealing of gaps and cracks.

The air leakage through components such as doors or grilles should match the design specifications at the operating pressure.

The tester should confirm air permeability and air leakage limits with the client.

3 Test procedure

The suite's supply/extract ductwork shall not be used as a means of carrying out the tests.

Equipment shall have a UKAS calibration on an annual basis.

The tester shall discuss the test procedure with whoever is responsible for patient safety at the facility. Testing should not be carried out if doing so would compromise patient safety in any way.

The following test procedure shall be completed for both pressurisation and depressurisation tests within the isolation suite. The following procedure is based on ATTMA TSL2[1]. Where necessary, differences are stated:

1. The envelope area of each room comprising the isolation suite shall be established using the internal dimensions. It shall include the walls, ceiling and floor of each room.
2. All air-conditioning or mechanical ventilation systems serving the isolation suite and all adjacent areas shall be switched off for the duration of the test. This is to ensure that the areas subject to the test do not have elevated or depressed pressure relative to one another or to adjacent areas when the fan is not running.
3. A number of tests shall be carried out, depending on the type of isolation suite. Schedules of tests to be carried out on two types of isolation suite can be found in Section 4.
4. The ventilation grilles (supply and extract), pressure stabilisers and doors shall be either open, closed or sealed, depending on the test that is being carried out. As a general rule, when testing a room (for example an entrance lobby, an exit lobby, a patient's room, or an en-suite), the grilles in that room should be sealed, and adjacent rooms should not offer an advantage to the room tested.
5. Doors in adjacent areas shall be opened such that an equal pressure is achieved in all adjacent areas.
6. Where make-up air for the fan is drawn from the corridor, a door or window in the corridor shall be opened to ensure there is sufficient make-up air for the fan without depressurising the corridor.
7. Zero flow pressures taken in accordance with ATTMA TSL2 are likely to be near zero. If any of the averages $\Delta p_{0,1+}$, $\Delta p_{0,1-}$, $\Delta p_{0,2+}$ and $\Delta p_{0,2-}$ are greater than ±3 Pa, an investigation shall be undertaken to determine the cause, and this shall be noted in the test report.
8. For each test point, the room pressure (equivalent to building pressure in ATTMA TSL2) and airflow rate shall be recorded.

9. Test points shall be taken starting at a low pressure, increasing to a high pressure, with additional measurements at decreasing pressures to confirm no temporary seals have broken.
10. A minimum of 8 test points shall be recorded for each test (ATTMA TSL2 only requires 7 test points). Care is required to ensure that the room pressure and airflow rate have stabilised prior to each measurement. At least one test point with a room pressure of 10 Pa or less shall be recorded but no room pressures less than 1 Pa shall be recorded. Note that this requirement overrides the requirements in ATTMA TSL2 with regards to lowest acceptable building pressures.
11. The air permeability of each room and that of the overall suite shall be calculated using the formula:

$$W_{p,50} = q_{p,50} / A$$

Where:

- $W_{p,50}$ is the room/suite air permeability, measured in $m^3/(h.m^2)$ at a reference pressure of 50 Pa.
- $q_{p,50}$ is the corrected air flow rate at a reference pressure of 50 Pa, measured in m^3/h.
- A is the envelope area, including the walls, ceiling and floor, measured in m^2.

These results can be compared against the specified room/suite leakage criteria.

Figure 1: Flow pressurisation equipment during air permeability testing of an isolation suite

4 Test regime

The tests described in this section are used to calculate:

- The leakage through the envelope (walls, floor, ceiling) of the isolation suite as a whole and of each individual room
- The leakage through doors

The test regime assumes the extract ductwork is of sufficient size so as not to significantly influence the various air leakage measurements. All dampers associated with the supply and extract system shall be opened for the duration of the test. Failure to ensure these dampers are open could result in lower air permeability being measured. Any temporary sealing should be installed at the air terminal devices within the facility.

Calculations of the specific leakage rate through each element should be calculated based on the operating pressure differential for that element, as described in Appendices A and B.

The necessary air permeability tests for two isolation suite designs are described in Sections 4.1 and 4.2. Both designs are described in HBN-04-01 Supplement 1[3]. Other types of isolation suites may have supply and/or extract grilles in the patient's room. The airtightness tests should be carried following these guidelines, ensuring the supply and extract grilles are sealed for all tests.

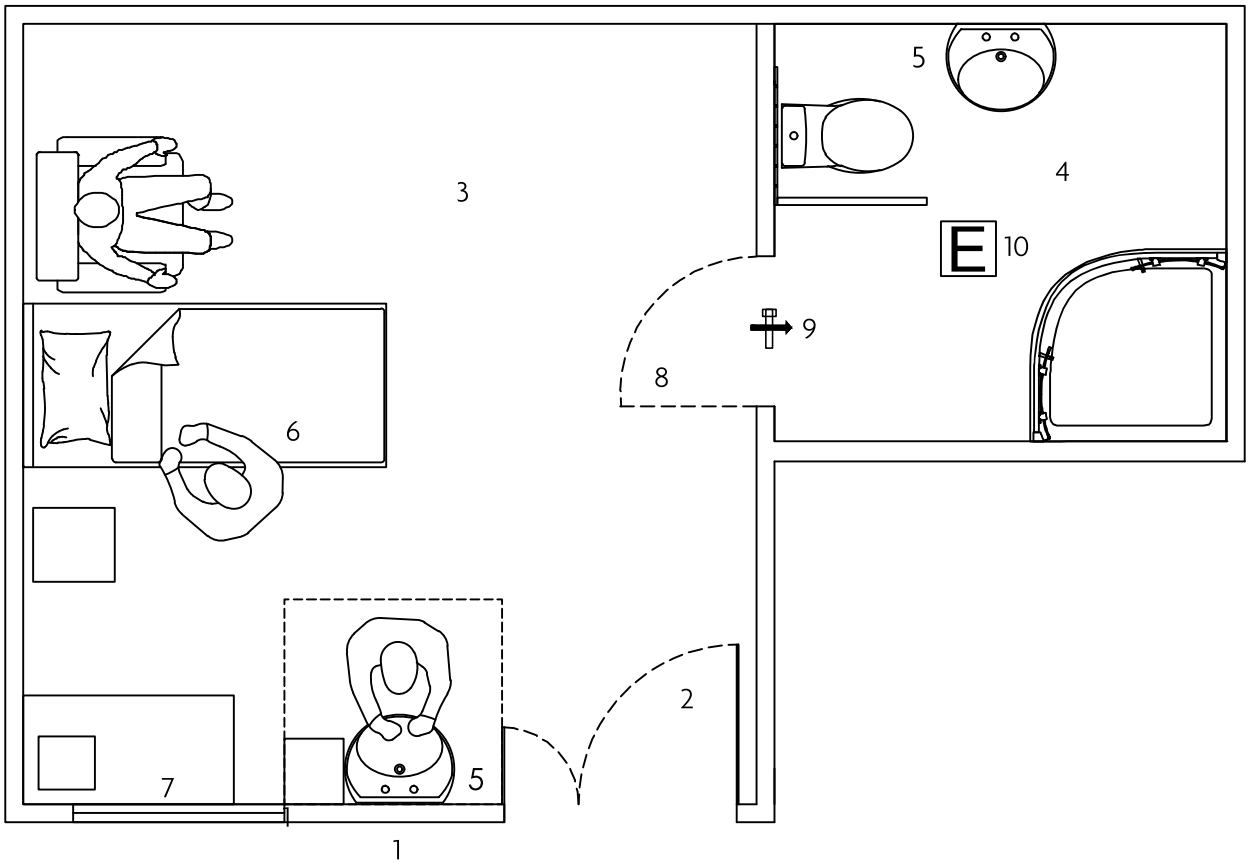
4.1 Suite 1: Single Bed Room

The layout of suite 1 is as described on page 10 of HBN 04-01 Supplement 1[3], "Sheet 1: New build single room with en-suite facilities". This is reproduced as Figure 2 opposite.

The suite consists of the patient's room and an en-suite. No specific operating pressures are given in HBN 04-01 Supplement 1. The double-leaf door from the corridor to the patient's room is necessary for wheeling the bed in and out of the patient's room. During normal operation, only one leaf of this door is used.

The door from the patient's room to the en-suite is normally closed. A grille in the bottom of this door allows air to transfer from the patient's room to the en-suite, where it is extracted.

Figure 2: Schematic of isolation suite 1



1. Corridor
2. Door from corridor to patient's room
3. Patient's room
4. En-suite
5. Washbasin
6. Bed
7. Window to corridor
8. Door from patient's room to en-suite
9. Transfer grille
10. Extract grille

Test regime

Table 1 shows the schedule of tests to be carried out and Table 2 shows how to use the air permeability test results to calculate the air permeability and the leakage through the isolation suite components. Figure 3 shows, for each test specified in Table 1, the configuration of the suite with the areas under test highlighted in blue and the state of each component during the test (open, closed, sealed etc.)

Table 1 Test schedule – Suite 1

For each test, a pressurisation and a depressurisation test should be carried out.

Test	Test Area	Door from corridor to patient's room	Door from patient's room to en-suite	En-suite door grille	Extract grille in en-suite
1	Overall isolation suite	FPE	O	S/U	S
2	Patient's room	FPE	C+S	S	U
3	Door from patient's room to en-suite	FPE	C	S	U
4	Patient's room (second test)	C	FPE	S/U	U
5	Door from patient's room to corridor	C+S	FPE	S/U	U
6	En-suite	O	FPE	S/U	S

O = Open

C = Closed, but not sealed

S = Sealed

C+S = Closed and sealed

U = Unsealed

S/U = Either sealed or unsealed; it doesn't affect the test

FPE = Fan pressurisation equipment

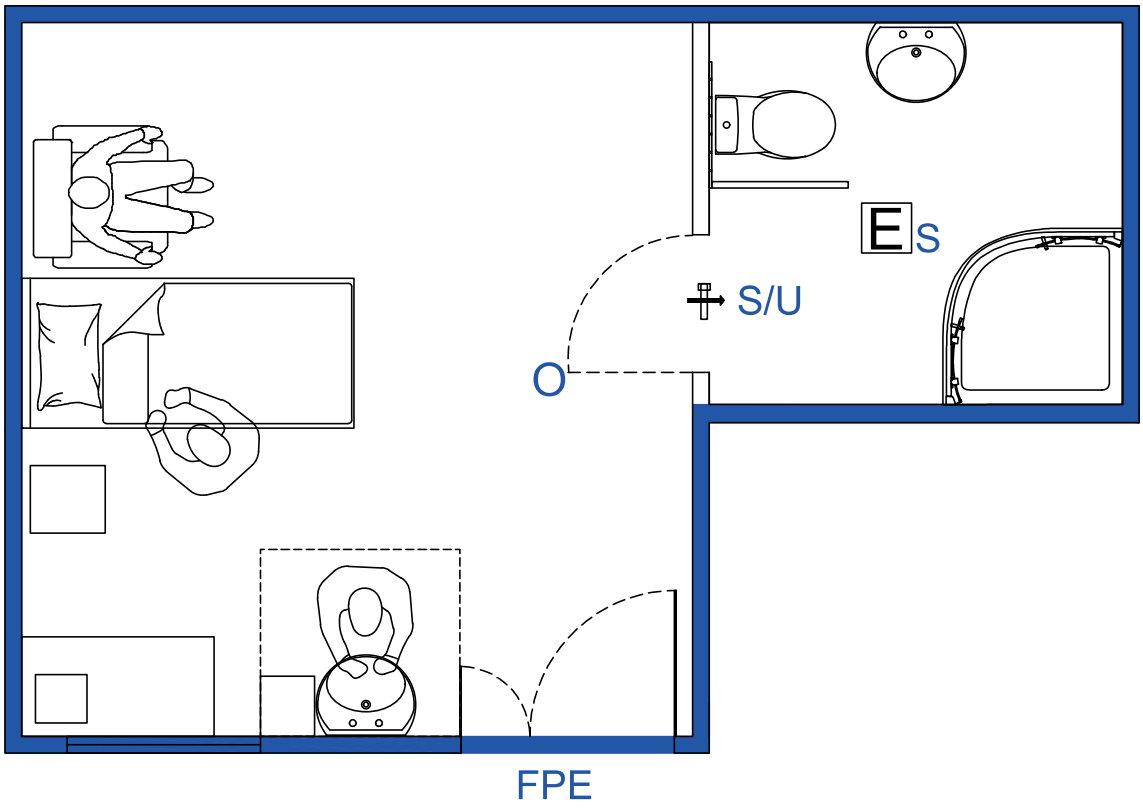
Table 2 Results calculations – Suite 1

Test	Results	Notes
Test 1	Air permeability of overall isolation suite	If the result of test 1 doesn't meet the limit specified, it may be advisable to identify leakage paths and carry out remedial work before proceeding to the remaining tests.
Test 2	Air permeability and specific leakage rate at operating pressure of patient's room	Calculate specific leakage rate at operating pressure using the method in Appendix A.
Tests 2 and 3	Air leakage at operating pressure through door from patient's room to en-suite	Subtract test 2 specific leakage rate from test 3 specific leakage rate, both at the operating pressure. This calculation is explained in Appendix C.
Tests 4 and 5	Air leakage at operating pressure through door from patient's room to corridor	Subtract test 4 specific leakage rate from test 5 specific leakage rate, both at the operating pressure. This calculation is explained in Appendix C.
Test 6	Air permeability and specific leakage rate at operating pressure of en-suite	Calculate the specific leakage rate at the en-suite's operating pressure using the method in Appendix A.

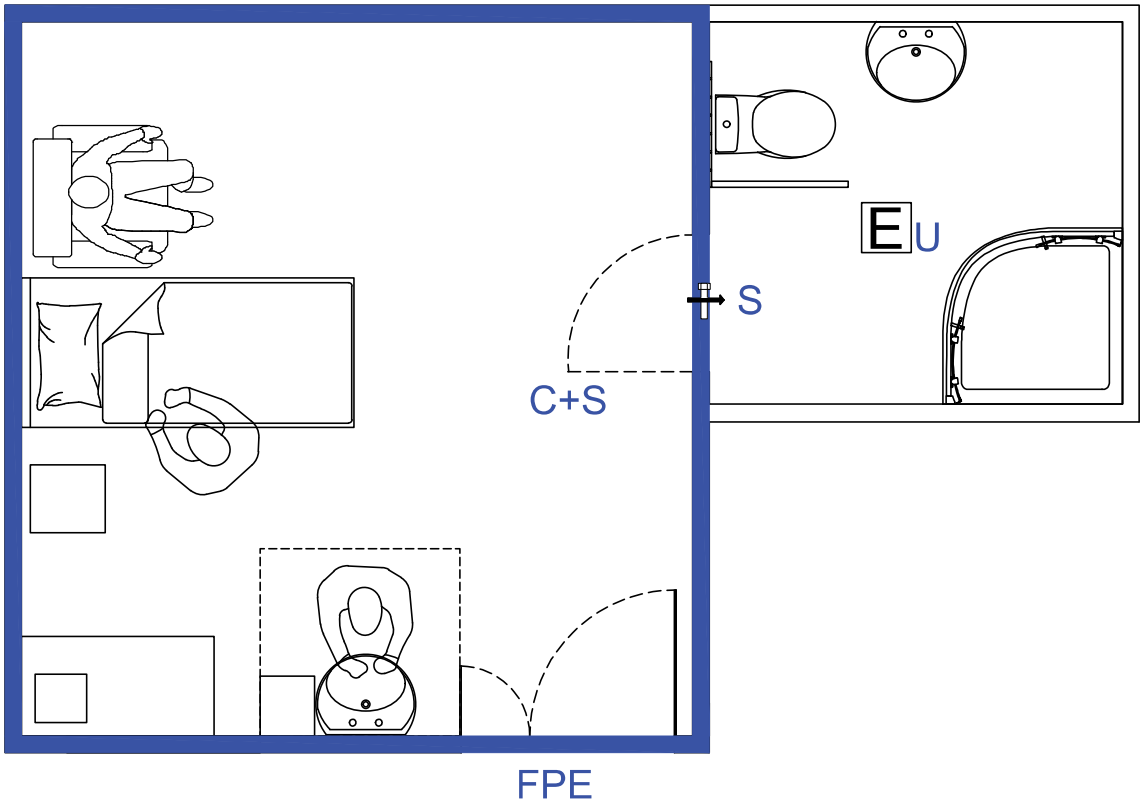
All results obtained can be compared against the limits specified at the design stage.

Figure 3: Test configurations – Suite 1

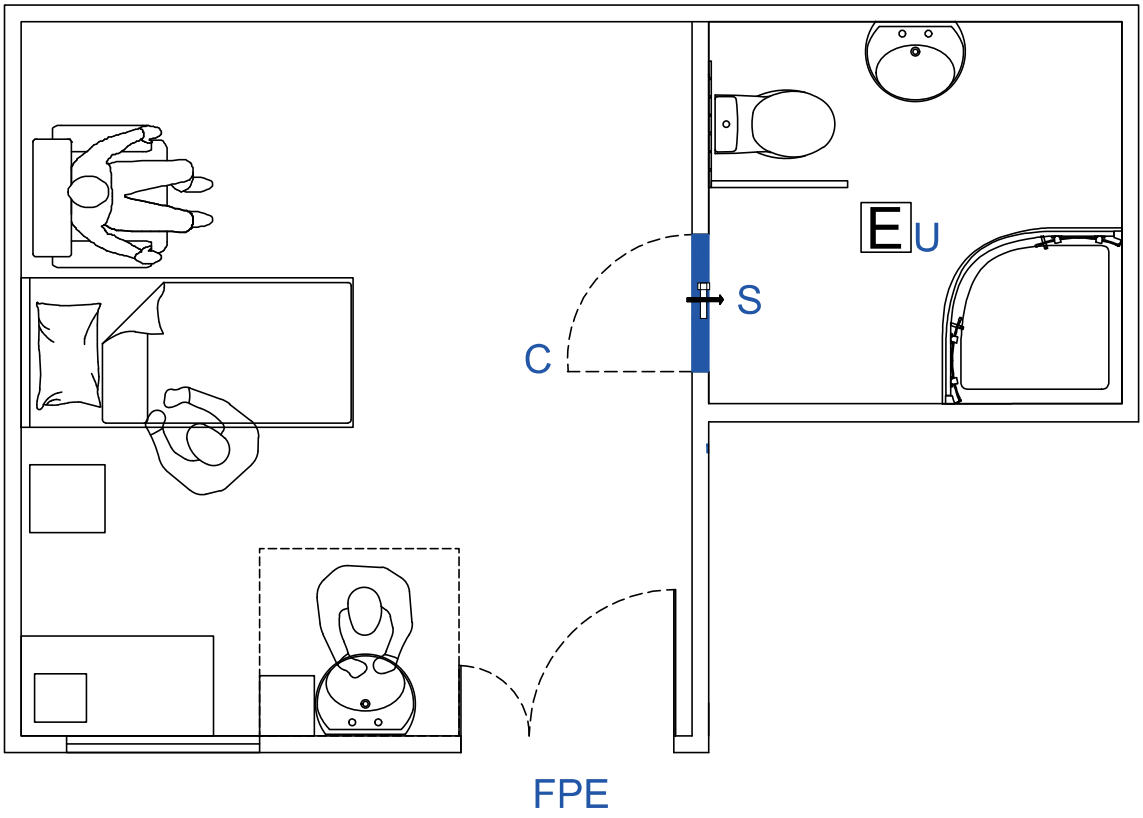
Suite 1 Test 1 – Overall isolation suite



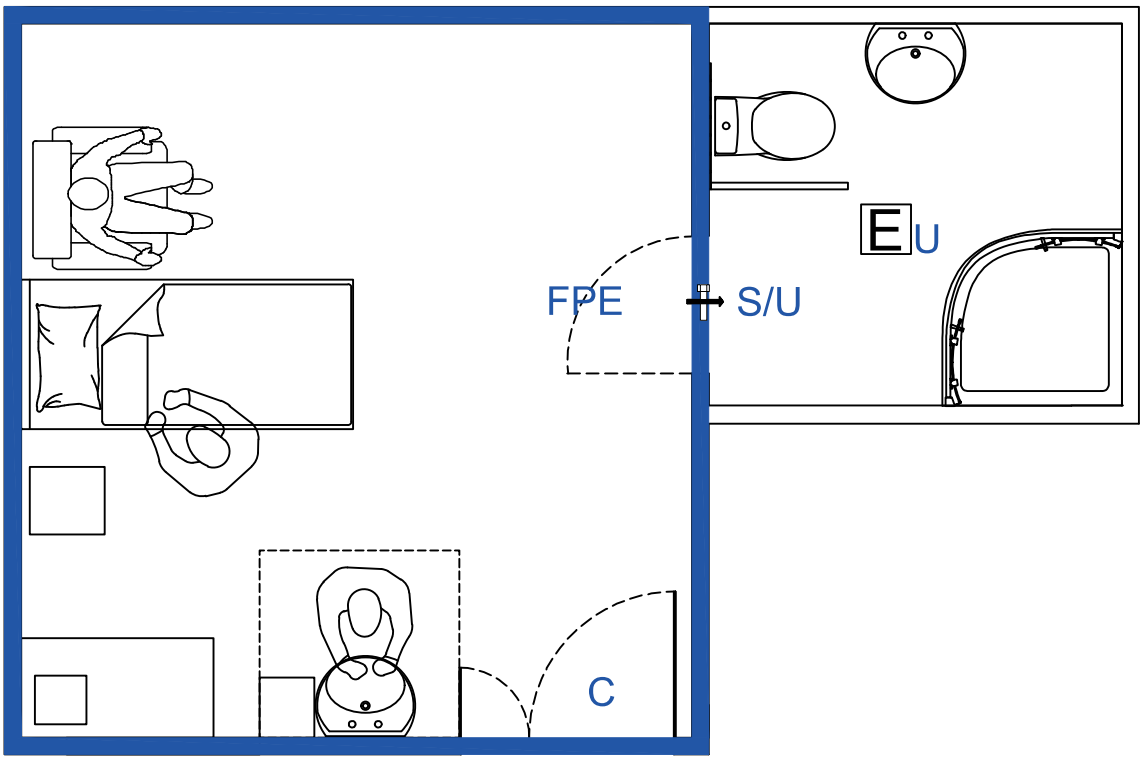
Suite 1 Test 2 – Patient's room



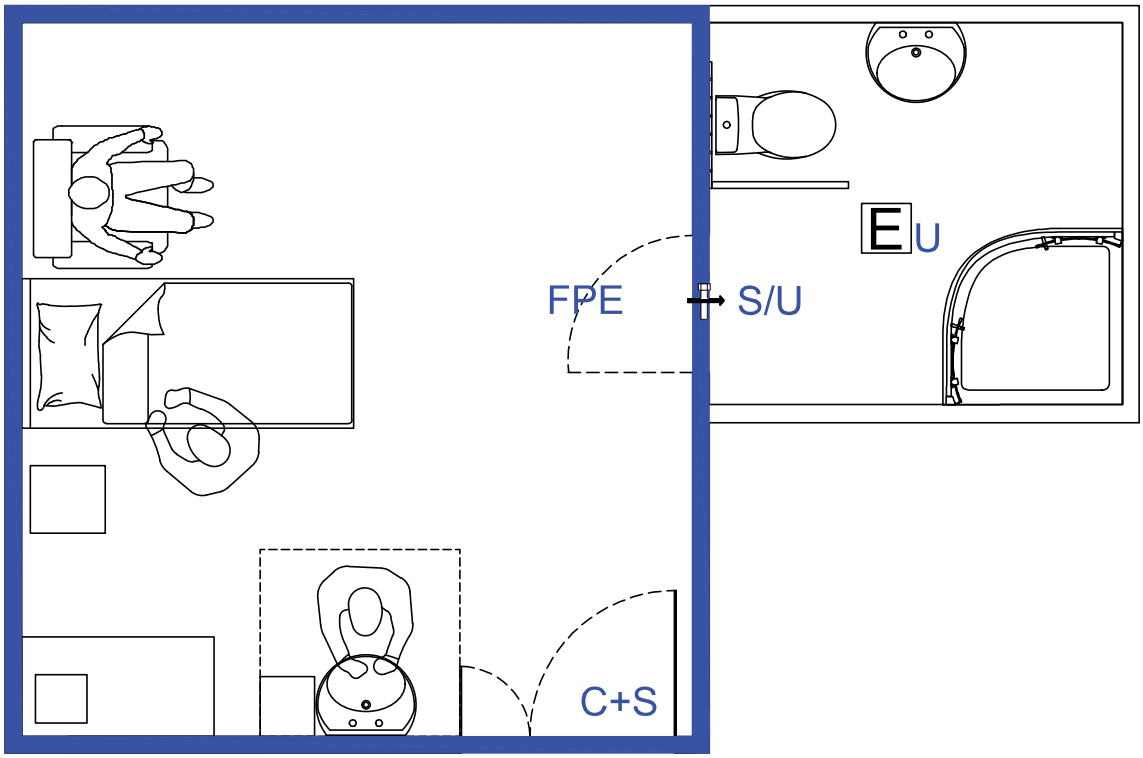
Suite 1 Test 3 – Door from patient's room to en-suite



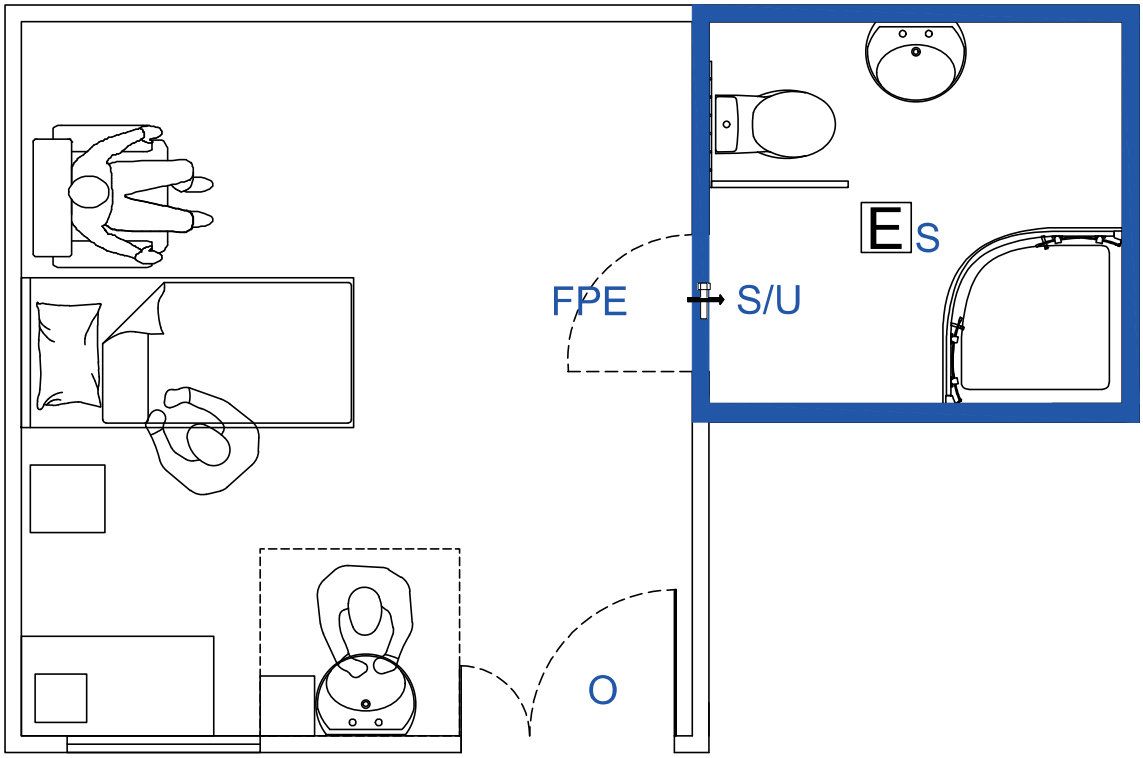
Suite 1 Test 4 – Patient's room



Suite 1 Test 5 – Door from patient's room to corridor



Suite 1 Test 6 – En-suite



4.2 Suite 2: Positive Pressure Ventilated Lobby (PPVL) Room

The layout of suite 2 is as described on page 11 of HBN 04-01 Supplement 1[3], "Sheet 2: New build single room with en-suite facilities and lobby". This is reproduced as Figure 4 overleaf.

The isolation suite consists of an entrance lobby, a patient's room and an en-suite. The operating pressures with respect to the corridor are stated in HBN 04-01 Supplement 1 as follows:

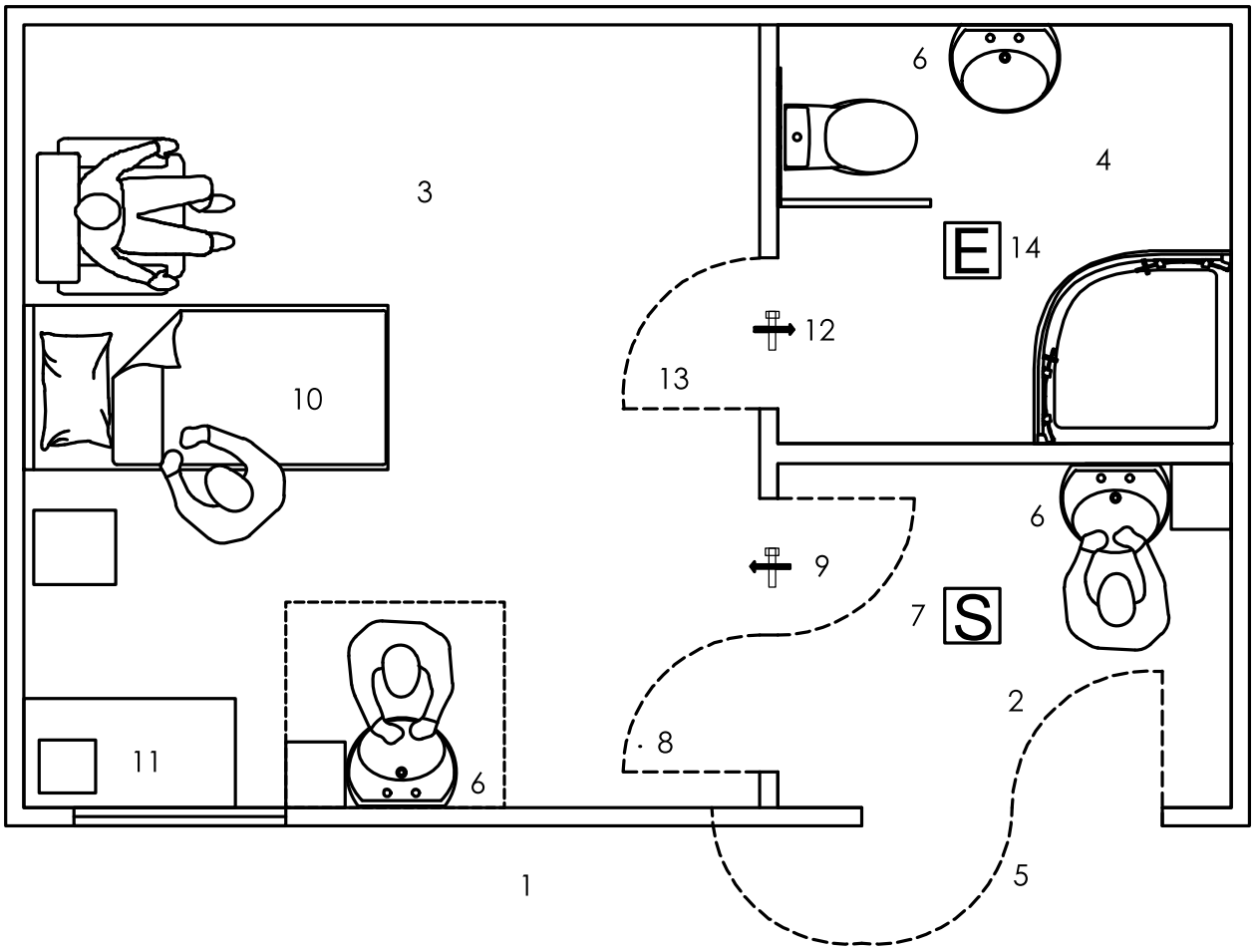
- Lobby: positive (10 Pa)
- Patient's room: neutral (0 Pa)
- En-suite: negative

The double-leaf door from the lobby to the corridor and from the lobby to the patient's room is necessary for wheeling the bed in and out of the patient's room. During normal operation, only one leaf of this door is used.

This design does not have supply or extract grilles in the patient's room. Air is supplied mechanically into the lobby through an air terminal device. A pressure stabiliser, located above the door from the lobby to the patient's room, supplies air into the patient's room when the differential pressure between the two spaces is 10 Pa.

The door from the patient's room to the en-suite is normally closed. A grille in the bottom of this door allows air to transfer from the patient's room to the en-suite, where it is extracted.

Figure 4: Schematic of isolation suite 2



1. Corridor
2. Entrance lobby
3. Patient's room
4. En-suite
5. Door from corridor to lobby
6. Washbasin
7. Supply grille
8. Door from lobby to patient's room
9. Pressure stabiliser
10. Bed
11. Window to corridor
12. Transfer grille
13. Door from patient's room to en-suite
14. Extract grille

Table 3 shows the test schedule and Table 4 shows how to use the air permeability test results to calculate the air permeability and the leakage through the isolation suite components. Figure 5 shows, for each test specified in Table 3, the configuration of the suite with the areas under test highlighted in blue and the state of each component during the test (open, closed, sealed etc.)

Table 3 Test schedule – Suite 2

For each test, a pressurisation and a depressurisation test should be carried out.

Test	Test Area	Door from corridor to lobby	Door from lobby to patient's room	Door from patient's room to en-suite	En-suite door grille	Supply grille in lobby	Extract grille in en-suite	Pressure stabiliser
1	Overall isolation suite	FPE	O	O	S/U	S	S	S/U
2	Lobby	FPE	C+S	O	S/U	S	U	S
3	Door from lobby to patient's room	FPE	C	O	S/U	S	U	S
4	Patient's room	O	FPE	C+S	S	S/U	U	S
5	Door from patient's room to en-suite	O	FPE	C	S	U	U	S
6	En-suite door grille	O	FPE	C+S	U	U	U	S
7	Lobby (second test)	C+S	FPE	O	S/U	S	U	S
8	Door from lobby to corridor	C	FPE	O	S/U	S	U	S
9	En-suite	O	O	FPE	S/U	S/U	S	S/U

O = Open

C = Closed, but not sealed

C = Sealed

C+S = Closed and sealed

U = Unsealed

S/U = Either sealed or unsealed; it doesn't affect the test

FPE = Fan pressurisation equipment

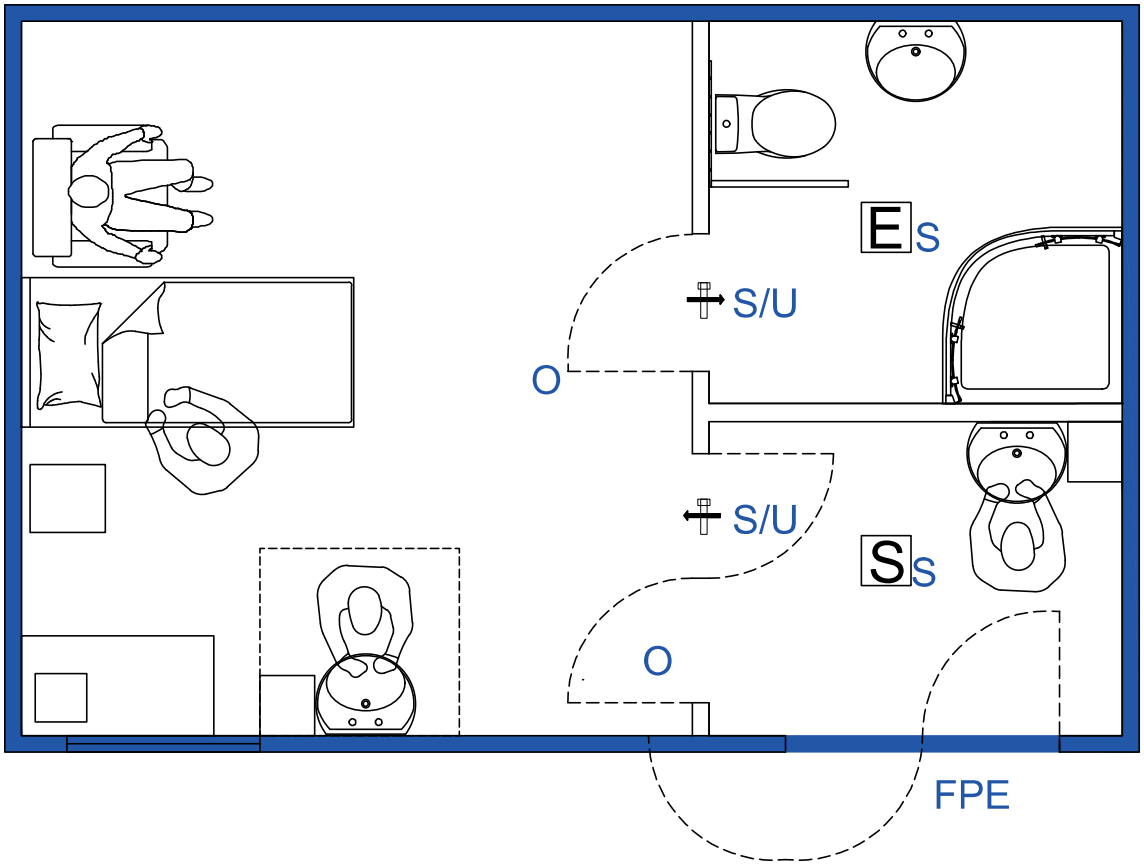
Table 4 Results calculations – Suite 2

Test	Results	Notes
Test 1	Air permeability of overall isolation suite	If the result of test 1 doesn't meet the limit specified, it may be advisable to identify leakage paths and carry out remedial work before proceeding to the remaining tests.
Test 2	Air permeability and specific leakage rate at operating pressure of lobby	Calculate specific leakage rate at operating pressure using the method in Appendix A.
Tests 2 and 3	Specific leakage rate at operating pressure through door from lobby to patient's room	Subtract test 2 specific leakage rate from test 3 specific leakage rate, both at the operating pressure. This calculation is explained in Appendix C.
Test 4	Air permeability and specific leakage rate at operating pressure of patient's room	Calculate specific leakage rate at operating pressure using the method in Appendix A.
Tests 4 and 5	Specific leakage rate at operating pressure through door from patient's room to en-suite	Subtract test 4 specific leakage rate from test 5 specific leakage rate, both at the operating pressure. This calculation is explained in Appendix C.
Tests 4 and 6	Specific leakage rate at operating pressure through en-suite door grille	Subtract test 4 specific leakage rate from test 6 specific leakage rate, both at the operating pressure. This calculation is explained in Appendix C.
Test 7	Air permeability and specific leakage rate at operating pressure of lobby	Calculate specific leakage rate at operating pressure using the method in Appendix A. Results should be similar to test 2. This test is done to avoid any errors in the calculation due to possible leakage of the FPE.
Tests 7 and 8	Air leakage at operating pressure through door from lobby to corridor	Subtract test 7 leakage from test 8 leakage, both at the operating pressure. This calculation is explained in Appendix C.
Test 9	Air permeability and specific leakage rate at operating pressure of en-suite	Calculate specific leakage rate at operatng pressure using the method in Appendix A.

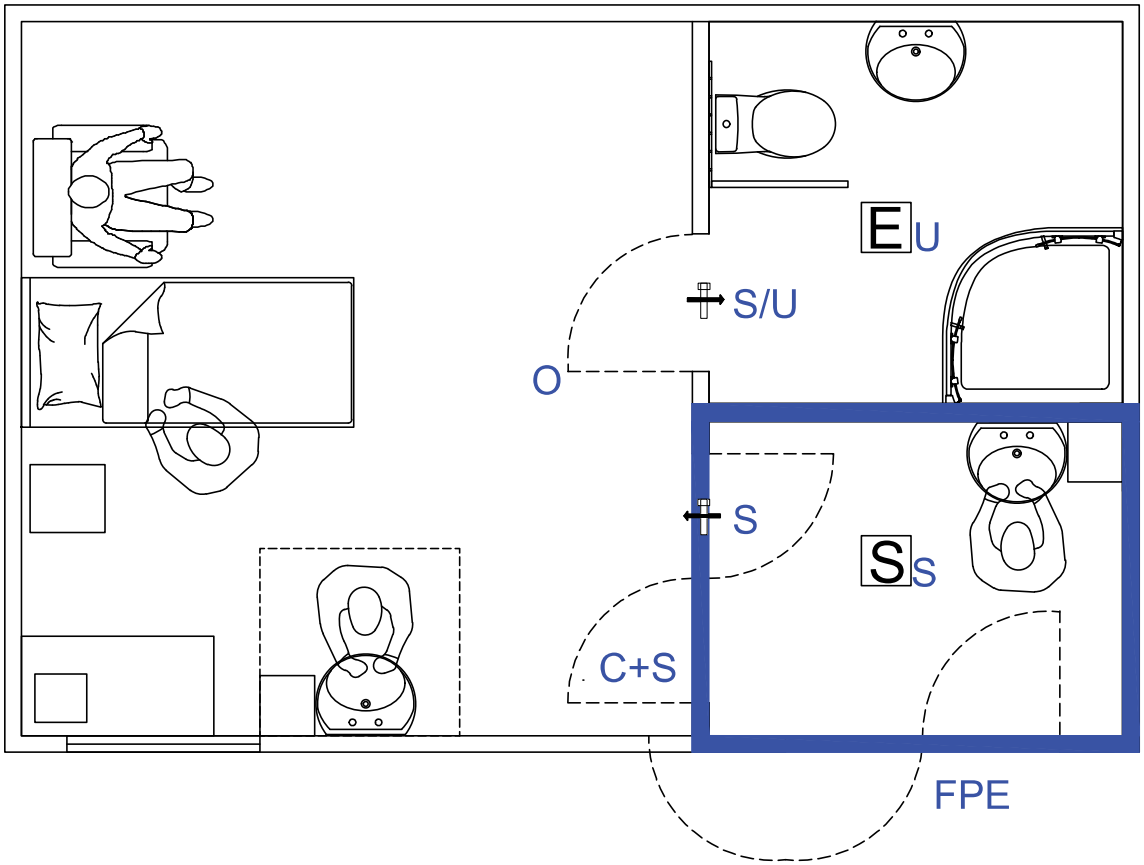
All results obtained can be compared against the limits specified at the design stage.

Figure 5: Test Configurations – Suite 2

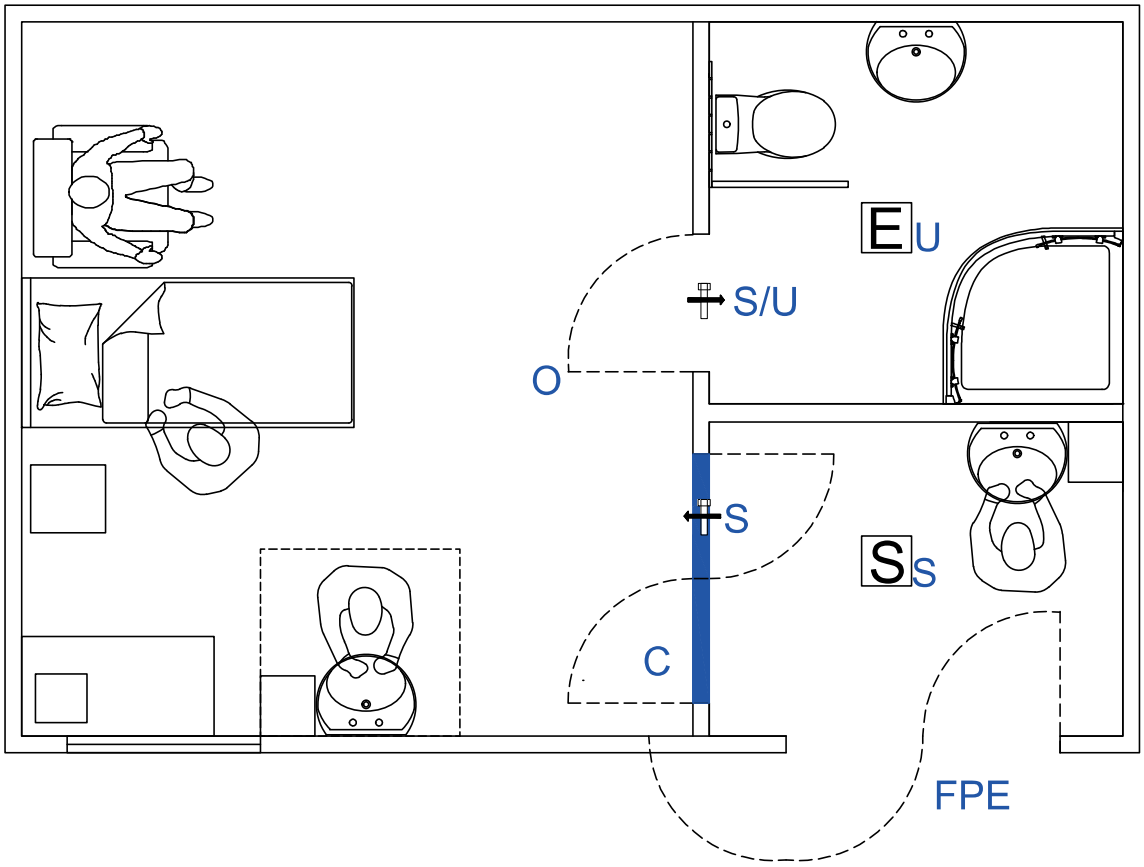
Suite 2 Test 1 - Overall isolation suite



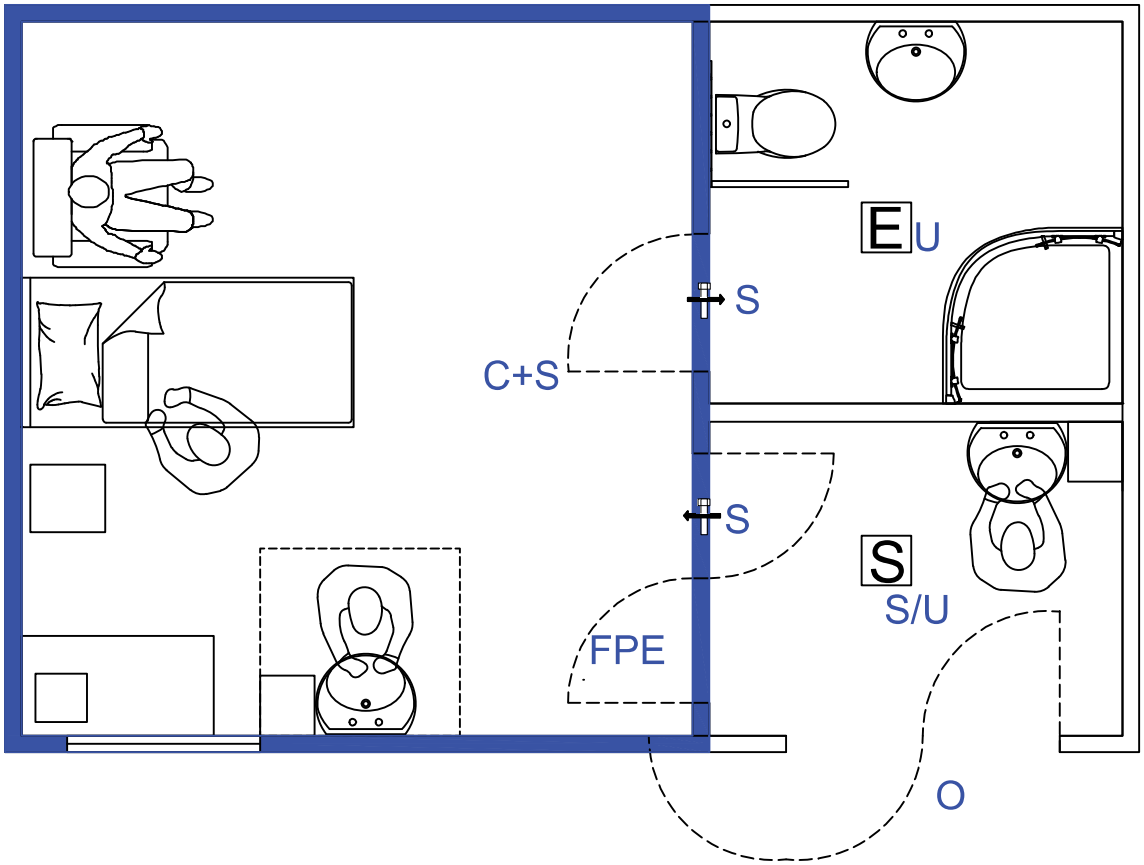
Suite 2 Test 2 - Lobby



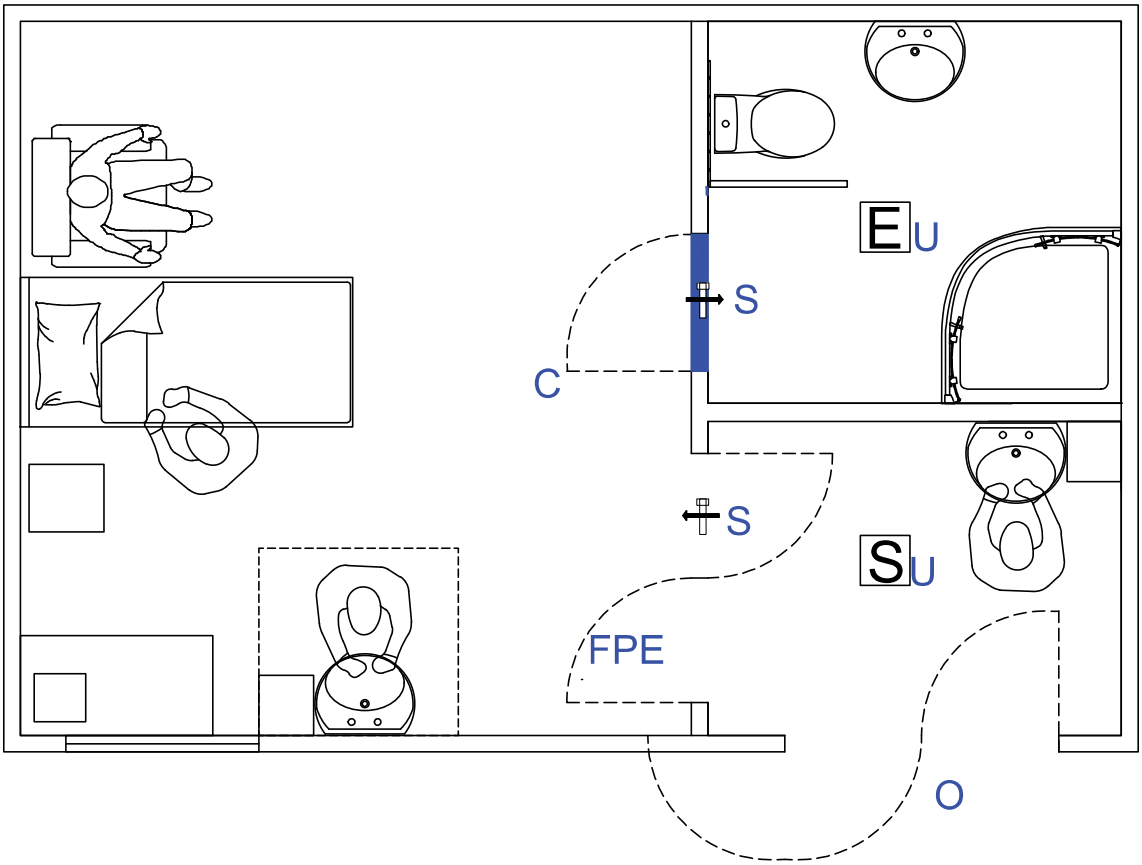
Suite 2 Test 3 – Door from lobby to patient's room



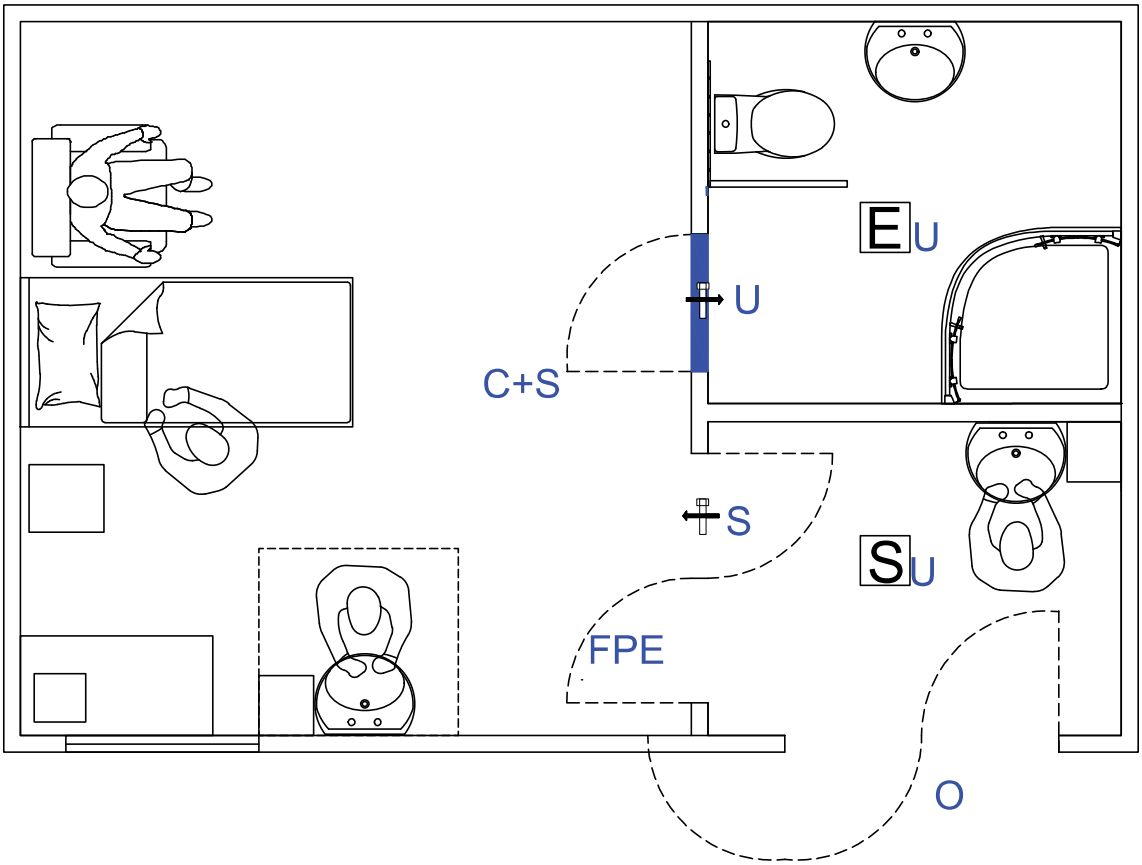
Suite 2 Test 4 – Patient's room



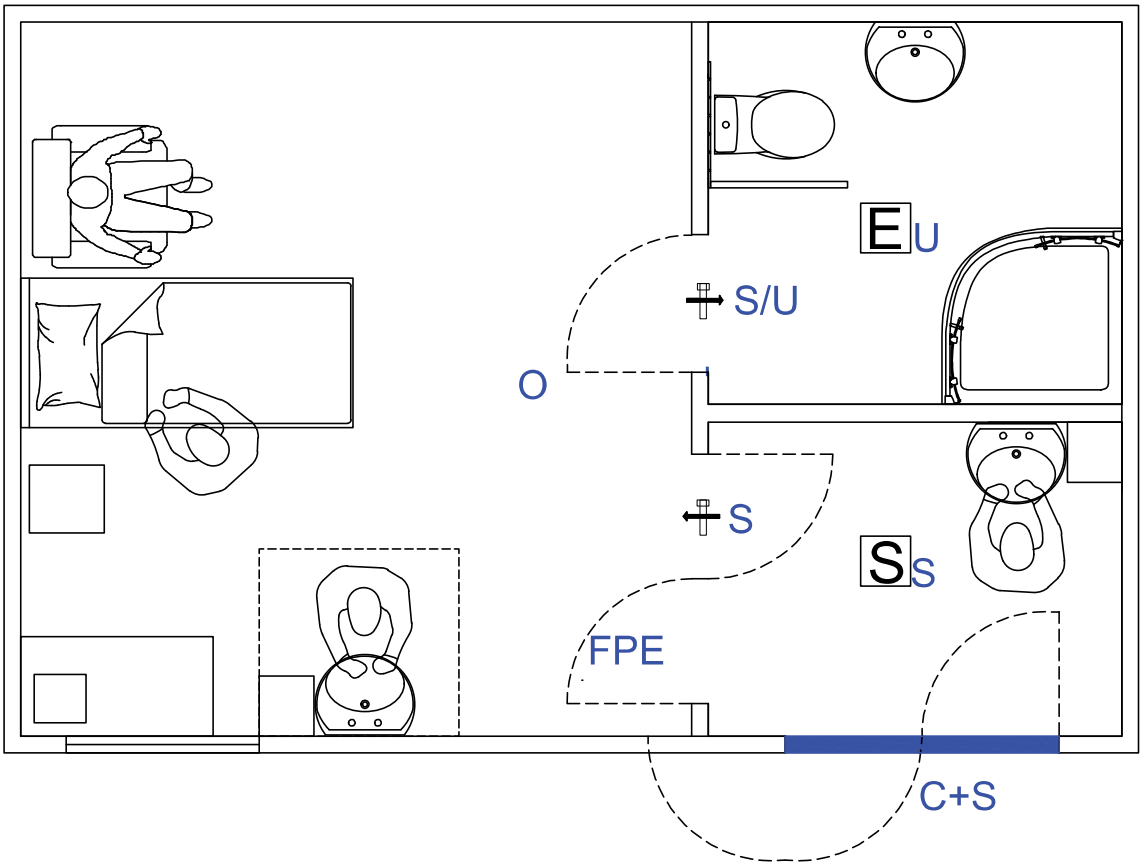
Suite 2 Test 5 – Patient's room to en-suite



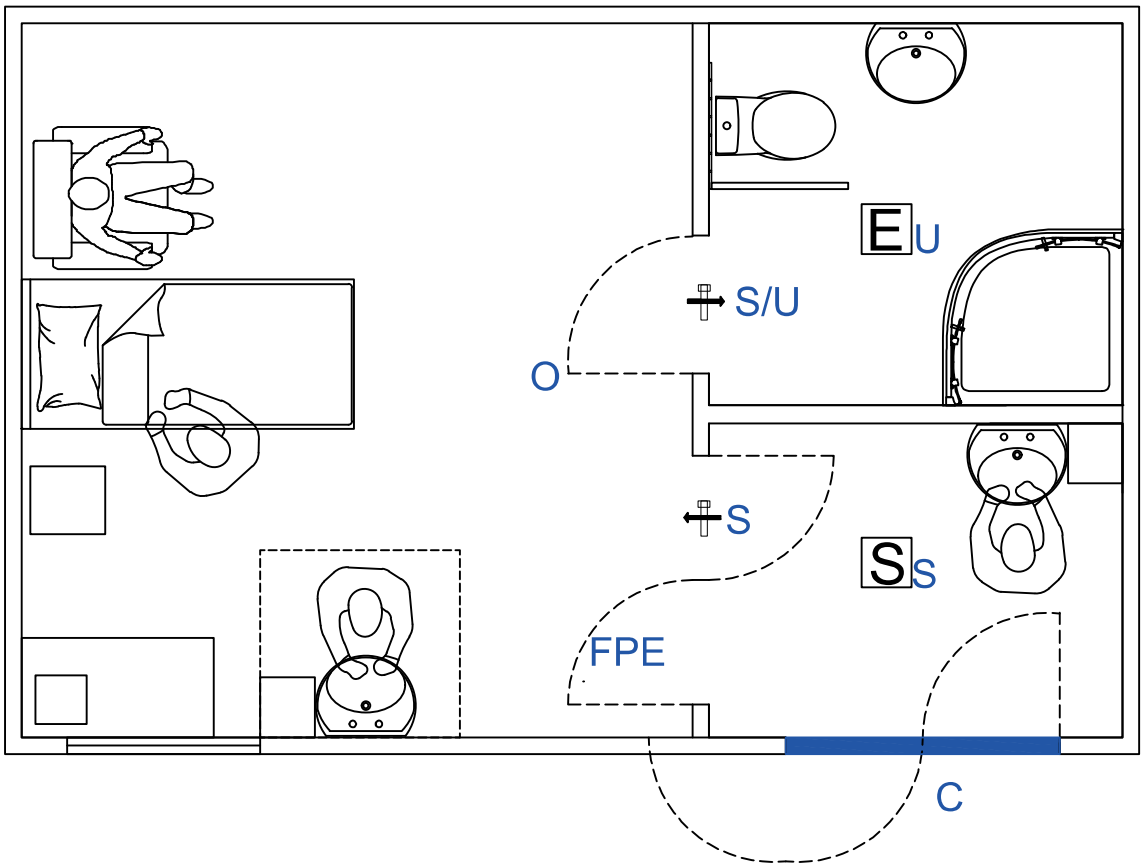
Suite 2 Test 6 – En-suite door grille



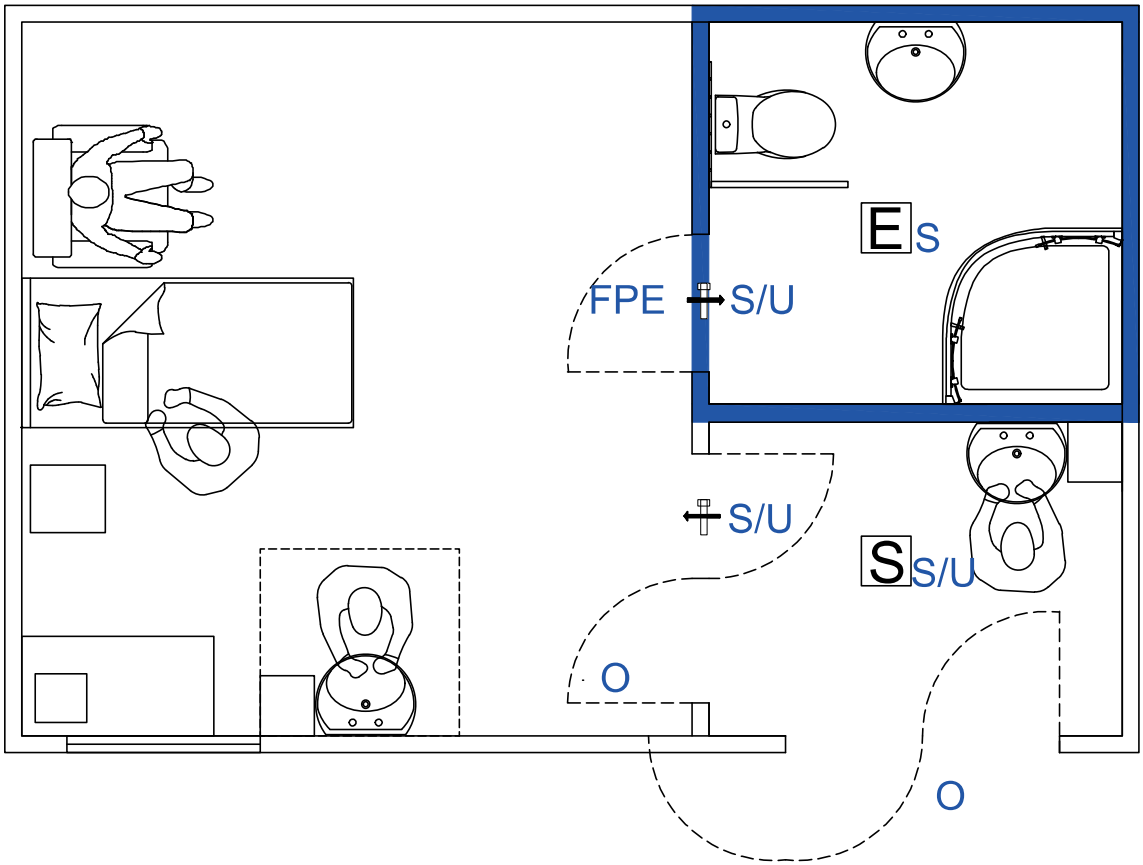
Suite 2 Test 7 – Lobby



Suite 2 Test 8 – Door from lobby to corridor



Suite 2 Test 9 – En-suite



5 Test report

The report should contain the results of all tests undertaken on particular rooms and include the following information for each test:

1. All details required to identify the room tested, including the name of the hospital, area within the hospital and room name/number, room condition (either new or in operation) and, where known, date of construction.
2. Date and time of each test
3. Reference to this standard, and any deviations from this standard
4. Test descriptions and results for each test
5. Detailed description of equipment used, including unique reference number of equipment, and calibration certificate.
6. The following data for each test:
    a. Zero-flow pressure differences ($\Delta P_{0,1+}$, $\Delta P_{0,1-}$, $\Delta P_{0,1}$, $\Delta P_{0,2+}$, $\Delta P_{0,2-}$, $\Delta P_{0,2}$)
    b. Barometric pressure
    c. Measured pressure differences and corresponding corrected air flow rates
    d. Graph depicting the room pressure difference against corrected flow rate.
    e. Correlation coefficient
    f. Air flow coefficient
    g. Air flow exponent
    h. Envelope area
    i. Air leakage rate at 50 Pa.
7. Summary of results which should include the pressurisation, depressurisation and average air permeability / specific leakage rate as applicable for each test.
8. Calculations derived from tests, as specified in Tables 2 and 4.

Appendix A: Calculation of specific leakage rate

It is often useful to establish the specific leakage rate – i.e. the leakage rate at a given pressure other than the 50 Pa reference pressure used in air permeability testing.

Air leakage is related to room pressure by the equation $Q = C \times (\Delta P)^n$

Where:

Q = air leakage

C = airflow coefficient

ΔP = room pressure

n = exponent

From this, the following equation can be derived which can be used to establish the air leakage at any room pressure (ΔP_1), given the air leakage at any other room pressure (ΔP_2):

$$Q_1 = Q_2 \times (\Delta P_1 / \Delta P_2)^n$$

If an air permeability test has been carried out, the exponent (n) will be known and can be substituted into the above equation. Otherwise, a representative value can be used. In the example below, a typical value of n = 0.65 has been assumed.

Example calculation

A failure has occurred in the extract system of an isolation facility, resulting in a positive pressure of 20 Pa being applied to that room for a short period until the supply fan is switched off. What will be the rate of air leakage from that room into surrounding spaces?

Input data:

Room dimensions: W = 4 m, L = 6 m, H = 3 m

Air permeability = 2 $m^3/(h.m^2)$@50Pa

Air flow exponent, n = 0.65

Positive pressure on failure of extract system = 20 Pa

Calculation:

Envelope area = 2 × (W × L + L × H + W × H)

= 2 × (4 m × 6 m + 6 m × 3 m + 4 m × 3 m)

= 108 m^2

Leakage rate of the room at 50 Pa, Q_{50} = Air permeability × Envelope area

= 2 $m^3/(h.m^2)$@50Pa × 108 m^2

= 216 m^3/h

= 60 l/s

Specific leakage rate of the room at 20 Pa, $Q_{20} = 216 \times (20/50)^{0.65}$

= 119 m^3/h

= 33 l/s

Appendix B: Calculation of leakage through individual elements

The air leakage through the individual walls, ceiling or floor of a room cannot be assessed independently; therefore it should be assumed that each wall of the room, its ceiling and its floor leaks at the same rate per square metre.

This can be formulated as follows:

Leakage through an element = Total leakage × Area of the element / Total envelope area

Example calculation
In the room described in the example calculation in Appendix A, how much leakage will occur through each wall, the ceiling and the floor?
Input data:

Room dimensions: W = 4 m, L = 6 m, H = 3 m

Air permeability = 2 $m^3/(h.m^2)$@50Pa

Operating pressure of room = 20 Pa

Total envelope area = 108 m^2 (calculated during the example calculation in Appendix A)

Leakage of the room at 20 Pa, Q_{20} = 119 m^3/h (result from the example calculation in Appendix A)

Calculation results:

Element	Area	Leakage through element at 20 Pa
Wall 1	4 m × 3 m = 12 m^2	13.2 m^3/h
Wall 2	4 m × 3 m = 12 m^2	13.2 m^3/h
Wall 3	6 m × 3 m = 18 m^2	19.8 m^3/h
Wall 4	6 m × 3 m = 18 m^2	19.8 m^3/h
Floor	4 m × 6 m = 24 m^2	26.4 m^3/h
Ceiling	4 m × 6 m = 24 m^2	26.4 m^3/h
Total	108 m^2	119 m^3/h

This assumes each wall has the same air permeability value

Appendix C: Calculation of leakage through doors

It is often useful to know the leakage through the gaps around a door at the operating pressure. This cannot be measured directly, however, it can be calculated as follows:

1. Carry out an air permeability test on the room with the door closed but not sealed.
2. Repeat the test with test configuration unchanged except for the door being closed and sealed.
3. For each test, record the airflow at 50 Pa (Q50) and the exponent (n). These figures are provided by all commercially available airtightness testing software.
4. For each result, use the following formula to obtain the specific leakage rate at the operating pressure (OP):

   $Q_{OP} = Q_{50} \times (\Delta P_{OP}/50)^n$

5. Subtract the step 2 specific leakage rate from the step 1 specific leakage rate to obtain the leakage rate of the gaps around the door at the operating pressure.

Both tests should be carried out so air leakage occurs in the same direction as it would during normal operation. The door may have quite different leakage characteristics depending on whether it is subjected to a positive or negative pressure.

Example Calculation

How much leakage will occur through the door when subjected to an operating pressure of 10 Pa? The room has been tested to give the following air permeability results:

Test 1: (door closed but not sealed): Q_{50} = 435.48 $m^3/h@50Pa$, n = 0.5632

Test 2: (door closed and sealed): Q_{50} = 113.12 $m^3/h@50Pa$, n = 0.5791

Calculation results:

Door closed but not sealed: $Q_{10} = 435.48 \times (10/50)^{0.5632}$
$= 175.92\ m^3/h$

Door closed and sealed: $Q_{10} = 113.12 \times (10/50)^{0.5791}$
$= 44.54\ m^3/h$

Leakage through door cracks at 10 Pa = 175.92 m^3/h – 44.54 m^3/h = 131.38 m^3/h

REFERENCES

1. The Air Tightness Testing and Measurement Association Technical Standard L2 *Measuring air permeability in the envelopes of buildings (non-dwellings)*
   Available as a free download from www.attma.org.

2. Health Building Note 4 Supplement 1 *Isolation facilities in acute settings* 2005 (superseded)

3. Health Building Note 04-01 Supplement 1 *Isolation facilities for infectious patients in acute settings* 2013
   Available as a free download from www.gov.uk.

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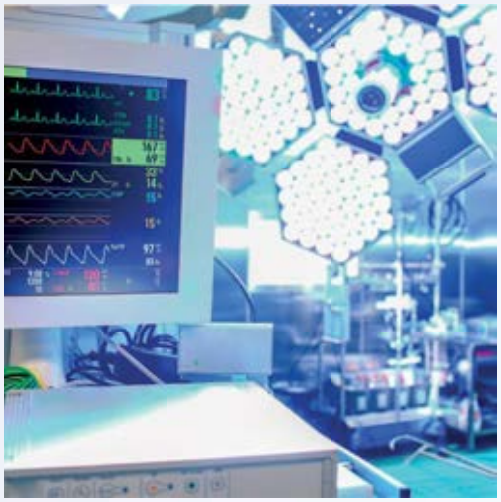

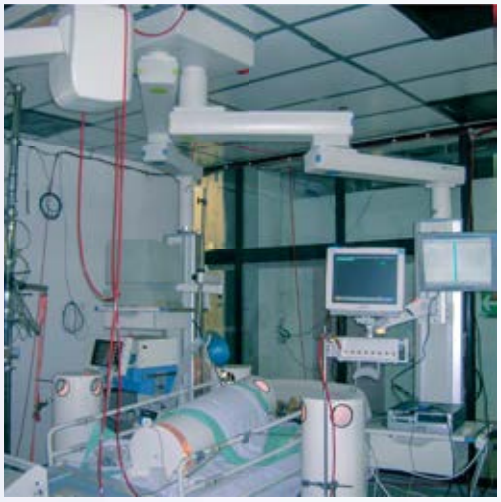

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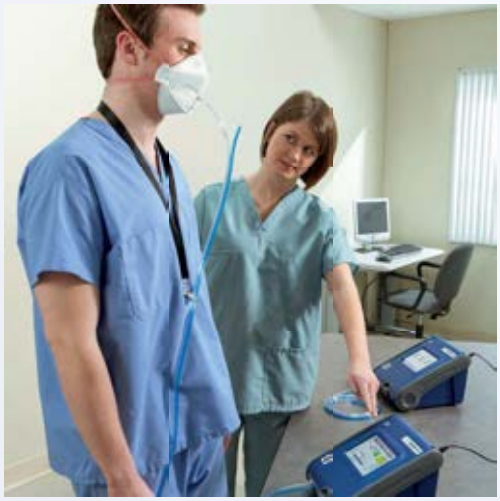

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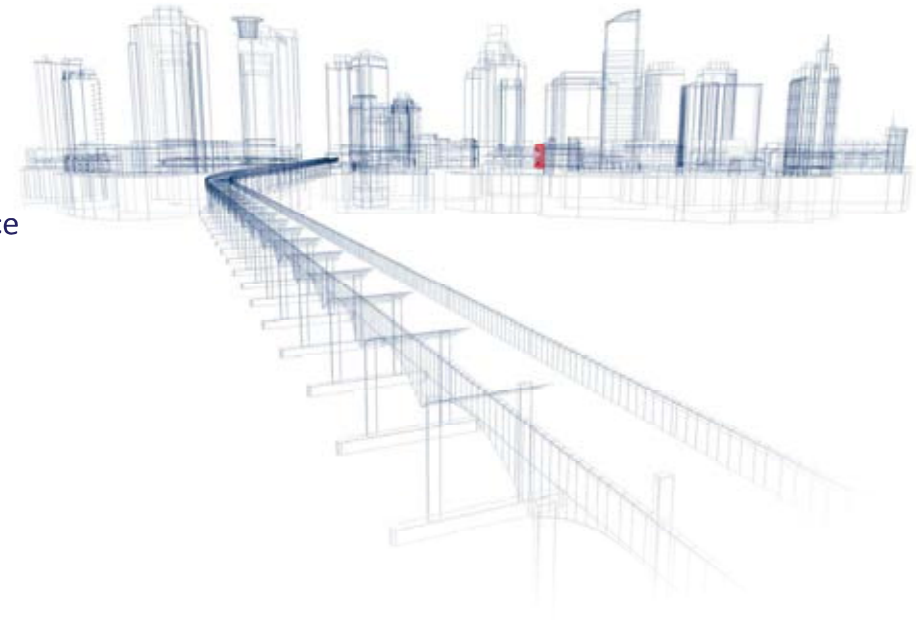

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Head Office: Old Bracknell Lane West, Bracknell, Berkshire RG12 7AH UK
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BSRIA North: 68 Walton Summit Road, Bamber Bridge, Preston PR5 8AQ UK
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New South Glasgow Hospitals (NSGH) Project

INVITATION TO PARTICIPATE IN COMPETITIVE DIALOGUE

VOLUME 2/1

EMPLOYER'S REQUIREMENTS (Hospitals)

Contents

Section 6.0 Construction Phase Requirements

6.1 Site Welfare and Board Accommodation
6.2 Site Preparation Works
6.3 Workmanship, Construction Accuracy and Tolerances
6.4 Live Hospital Site (incl other works on site)
6.5 Standardisation and Prefabrication
6.6 Room Mock-Ups
6.7 Witnessing and Testing
6.8 Commissioning and Handover

Section 7.0 Architectural Requirements (incl equipment)

7.1 Masterplan
7.2 Exemplar Design
7.3 Ceiling Heights & Voids
7.4 Corridor Widths
7.5 Doors
7.6 Windows
7.7 Building Envelope
7.8 Acoustics
7.9 Finishes
7.10 Interior Design
7.11 Architectural Hardware
7.12 Staircases, Ramps, Balustrades, Walkways, Escalators & Lifts
7.13 Landscape Design
7.14 Soft Landscaping Requirements
7.15 Wayfinding & Signposting
7.16 Protection
7.17 Integration of Healing Arts Strategy
7.18 Secure by Design

Section 8.0 Building Services Requirements

8.1 General Services
8.2 Mechanical Systems
8.3 Electrical Systems

Section 9.0 Civil and Structural Engineering Requirements

9.1 General Requirement
9.2 Minimum Design and Construction Standards
9.3 Loading & Structural Flexibility
9.4 Foundations & Substructure
9.5 Basements & Tunnels
9.6 Movement Joints
9.7 Superstructure
9.8 Fire & Corrosion Protection
9.9 Durability & Maintainability
9.10 Other Performance Requirements
9.11 Underground Drainage
9.12 Roads, Footpaths, Cycle Paths and Car Parking
9.13 Other External Works
9.14 Hard Landscaping Requirements

APPENDICES

Appendix M **Mechanical & Electrical Information**
M&E.1 Building Services and Utility Connections
M&E.2 Base Building Loads
M&E.3 Plant Strategy and Design Criteria
M&E.4 Sustainable Design Considerations
M&E.5 Integrated Building Management System
M&E.6 Renal Water
M&E.7 Pneumatic and Automated Material Transfer Systems
M&E Drawings

Appendix N **Site Investigation Information**

Appendix O **Environmental Assessment**

Appendix P **Board Policies**
P.1 List of Board Policies
P.2 Board Carbon Management Plan
P.3 Draft Operational Policies

Appendix Q **Related Design Information**

Appendix R **Fire Strategy**

Appendix S **Acoustic Requirements**

Appendix T **Pre-Construction Information (CDMC)**

Appendix U **BREEAM Guidance**

Appendix V **Community Benefits**

Appendix W **Travel Plan**

Appendix X **Critical Failures**

Section 1.0 Development Context

1.1 Introduction

The provision of new facilities at the Southern General Hospital site in Glasgow represents the second phase of the Acute Services Strategy of the Board.

As illustrated in Appendix A, the Hospital Campus extends to some 28.6 hectares and is located within the Govan area, lying to the south-west of Glasgow City Centre adjacent to the residential neighbourhood of Drumoyne and the industrial areas of Shieldhall and King George V Dock. The site is located 500 metres south of the River Clyde. The sites northern boundary is defined by Renfrew Road/Govan Road with the eastern boundary defined by Moss Road/A739 (Clyde Tunnel approach road). Langlands Drive and residential developments delineate the southern boundary and Hardgate Road runs north-westwards to identify the western boundary of the Hospital Campus.

The Site extends to some 8.6 hectares and is located in the west-central area of the Hospital Campus (see Appendix A). The Site is bounded by operational healthcare buildings to three sides, with boundaries to neighbouring industrial areas to the north/north-west. The existing buildings within the Site (excluding the Surgical Block) are to be demolished by the Board in advance of the scheme, as described in Section 2.3 below.

The scheme includes the provision of 1,109 adult and 240 children's beds. The bed numbers are illustrated in *Table 1 – Proposed Bed Numbers – Adult and Children's Hospitals.* Key elements of the project include:

a. Development of an integrated adult acute and children's hospital proving the full range of acute health services;

b. Development of a new Laboratory facility including Mortuary and Post-Mortem Services, Biochemistry, Microbiology, Haematology and Medical Genetics;

c. Provision of a rooftop helipad; and

d. The supply and installation of Group 1 equipment, location and/or fitting of Group 2 equipment supplied by the Board and provision of structural, space and services requirements to support Group 3 and 4 equipment.

It should be noted that Information Management and Technology (IM&T) is outwith the project, the Board is procuring software and end-use hardware as part of a separate IM&T project. The Contractor shall, however, provide the required space within the building and the requisite hard infrastructure and containment, in accordance with Section 8.0 and Appendix M, to support the Board IM&T requirements

Adult Hospital		**Children's Hospital**	
Specialty	**Beds**	**Specialty**	**Beds**
General Medicine (incl MHDU + AAU)	405	Inpatient (incl critical care areas) (*12 beds in maternity facility)	193*
CCU	20	Short-stay (observation ward)	20
Stroke	26	Day Care/Day Surgery	27
Haematology	14	**Total Inpatient Beds**	**240**
Dermatology	18		
Nephrology	80		
Geriatric Medicine	93		
Surgery & Vascular (incl AAU)	164		
Urology	39		
Orthopaedics/rehab	139		
ENT	31		
ITU	20		
SHDU	23		
Clyde/Contingency	37		
Total Inpatient Beds	**1,109**		

Table 1 – Proposed Bed Numbers – Adult and Children's Hospitals

1.2 Accommodation Overview

1.2.1 New Adult Hospital

This will provide A&E services and acute specialist in-patient care as well as medical day services and out-patient clinics serving the local population.

Key components of the facility will include:

a. In Patient Accommodation
Surgical beds (general surgery, orthopaedics, urology, vascular, ENT and renal); Medical beds; Acute Assessment Unit – 118 beds, ICU/HDU/CCU – 79 beds, Acute Stroke – 26 Beds and Care of the Elderly 93 beds;

b. Out Patient Accommodation
Full range of general outpatient clinics including, among others, diabetic unit, respiratory, orthopaedics and urology;

c. Day Services
22 medical day bed area; 30 station dialysis unit;

d. Treatment & Diagnostic Services
Emergency Department, 20 operating theatres, imaging, and endoscopy;

e. Clinical Support Services
Pharmacy dispensary, medical physics, medical illustration. Laboratory services linked to the hospital by underground route and pneumatic tube system, aseptic unit within the children's hospital. The pneumatic system to extend across the abutment with maternity and the link to neurosciences to provide for expansion of the system to these areas; and

f. Non Clinical Support Services
Main entrance, medical records, administration, chaplaincy, social work, staff changing, switchboard, estates, facilities, security, catering, portering, domestic, management and energy centre.

1.2.2 New Children's Hospital

This will provide A&E services and a comprehensive range of inpatient and day case specialist medical and surgical paediatric services on a local, regional and national basis. The new development will also have outpatient facilities. The care strategy is that all of Glasgow's Children's Services (up to the age of 16 and up to 18 years where appropriate) will be provided at the New Children's Hospital. Of the 240 beds planned, around 20% of the beds will be for day patients and the balance for in-patient requirements.

Key components of the facility will include:

a. Outpatient Accommodation
Full range of Children's outpatient clinics including audiology, general paediatrics, orthopaedics, ENT etc;

b. Day Services
Circa 10 medical day beds; 4 dialysis stations and circa 25 day surgery beds;

c. Treatment & Diagnostic
Accident and Emergency, minor injuries, Imaging, 9 theatres, rehabilitation;

d. Clinical Support Services
Aseptic unit, pharmacy, medical physics, medical illustration (laboratory services linked to hospital by underground route and pneumatic tube system – tube system to be extended across abutment with maternity/neo-natal to provide for potential expansion of the system); and

e. Non Clinical Support Services
Facilities, ancillary services, administration, spiritual services, medical records, staff change, staff dining.

1.2.3 **Laboratory Facilities**

The new facilities will be one of two major Laboratory sites in Glasgow (the other at Gartnavel General). The services planned to be delivered from the new Laboratory build at the New South Glasgow Hospitals include Biochemistry, Microbiology, Haematology, Medical Genetics, Mortuary and Post Mortem. The mortuary and post mortem facilities include the re-provision of the Glasgow City mortuary which also provides forensic services for the City of Glasgow. The Employer's Requirements in relation to the laboratory facilities form Volume 2/2 of the ITPD and laboratories (buildability and interfaces) shall form a workstream of competitive dialogue between the Board and bidders.

1.2.4 **Facilities Management Building and Energy Centre**

These key support accommodation areas shall be developed in line with the operational needs of the Board and the energy strategy adopted for the project. The Facilities Management accommodation is located in the Laboratory building and the requirements in this regard are included in Volume 2/2 of this ITPD.

1.2.5 **Retained Services**

The Southern General Hospital site will retain approximately 630 beds within the institute of neurological sciences, Maternity, Spinal Injuries and Langlands buildings. The Langlands facility provides older people's services, dermatology and services for the young physically disabled.

1.3 **Elements of Procurement**

1.3.1 As detailed in Volume 1 of the ITPD, the procurement is following a competitive dialogue route. The areas for inclusion in the competitive dialogue have been established, with the following topics identified:

a. Design;

b. Logistics;

c. Laboratories (incl FM accommodation); and

d. Commercial.

Volume 1 of the ITPD provides further detail on the scope, extent and requirements of the competitive dialogue, including identification of the issues and aspects of each topic that shall be considered.

1.3.2 As detailed in Volume 1 of the ITPD, the Works are comprised of several Stages, namely:

a. Stage 1 – Laboratory Design & Construction;

b. Stage 2 – Hospitals Detail Design to FBC;

c. Stage 3 – Construction of Hospitals; and

d. Stage 3A – Landscaping Completion (including demolition).

Section 2.0 Responsibilities of the Parties

2.1 Introduction

The Board wish to procure Works which shall enable it to carry out its clinical functions, to combat health acquired infection and to maintain physical assets and clinical and non-clinical functionality with ease; and it shall be the responsibility of the Contractor to deliver a design and construction solution that optimises these requirements. The Board wish to provide its clinical functions in a high quality care environment which is accessible to the community, welcoming, safe and aesthetically pleasing. Innovative design and construction proposals, which as a minimum meet the requirements of the Works Information, Site Information and Employer's Requirements are sought from the Contractor.

2.2 Responsibilities of the Contractor

The Contractor shall be responsible for the following:

2.2.1 Providing Works that are fit for purpose;

2.2.2 Meeting all of the requirements of the Board stated in the Works Information, Site Information and Employer's Requirements as a minimum requirement;

2.2.3 The tasks, risks and aspects of the project identified as owned by the Contractor in the Risk Register;

2.2.4 Assisting the Board with the management of the risks identified as owned by the Board in the Risk Register;

2.2.5 Working with the Board and it's advisers in fulfilling all of the requirements and good practice inherent in the NEC3 contract;

2.2.6 Compliance with the requirements of the Construction (Design & Management) Regulations;

2.2.7 Providing a design that meets the relationships identified in the Adjacency Matrix;

2.2.8 Diverting the culverts that cross the Site and the other remaining services;

2.2.9 Obtaining all Consents required for the construction of the Works, including but not limited to the under noted. With regard to the under noted the Contractor shall provide to the Board copies of the following documents within 10 working days of all purification and discharge notices from date of issue by the appropriate authority:

2.2.9.1 Planning Approvals;

2.2.9.2 Building Warrant (incl Stage applications if applicable);

2.2.9.3 Building Warrant – Certificates for full occupancy;

2.2.9.4 Pre-construction Information and Construction Phase Health &Safety Plan;

2.2.9.5 Health and Safety File;

2.2.9.6 Utilities Suppliers Consents;

2.2.9.7 Other Local Authority Consents, including Building Control, Roads Construction Consent, Fire Strategy etc;

2.2.9.8 Certification for PMG installation;

2.2.9.9 Relevant Civil Aviation Authority and Strathclyde Fire and Rescue documentation in relation to the provision by the Contractor of a rooftop helipad;

2.2.10 Procuring that the Works are at all times performed:

a. In compliance with all Law and Consents;

b. In a manner that is not likely to be injurious to health or to cause damage to property;

c. Without injury, nuisance, interruption to, or other detriment of the existing clinical and support services current on the site;

d. In a manner consistent with the Quality Plans;

e. Except to the extent expressly stated to the contrary in the Works Information, Site Information or Employer's Requirements in compliance with all NHS Mandatory Documentation, NHS Guidance Documentation and Additional Guidance contained in Section 5.1;

f. In a manner consistent with the Board discharging its statutory duties and other functions undertaken by it as the same may be notified to the Contractor from time to time;

g. In accordance with all British and European Standards; and

h. In accordance with Good Industry Practice.

2.3 **Responsibilities of the Board**

The Board is responsible for the following:

2.3.1 The provision of the area of the Site agreed between the Board and the Contractor clear of buildings and known utilities unless otherwise illustrated. This to include the grubbing out and removal of foundations and underbuildings. Remaining utilities to be addressed by the Contractor are identified on the drawing illustrating same in Appendix M; and

2.3.2 The provision of access (agreed by the Board in writing in advance) to areas of the Hospital Campus to allow the Contractor to make utility connections, corridor/building linkages and other relevant activities identified to carry out the Works.

Section 3.0 The Site

3.1 The Site

The Site is located at 1345 Govan Road within the Hospital Campus. The boundary of the Site is identified in Appendix A.

Site Investigation (SI) work has been undertaken by the Board. The relevant SI information and associated interpretative reporting is located in Appendix N.

3.2 Travel Plan

The draft Travel Plan developed by the Board is located in Appendix W.

3.3 Planning

Outline planning permission has been secured by the Board (a copy of the communication issued by GCC in relation to the permission is attached at Appendix D.1). The outline permission has forty-three conditions attached and was conditional to the Section 75 Agreement being concluded in respect of transportation issues.

The Section 75 Heads of Terms (HoTs) are agreed between the Board and the Council, the HoTs for a proposed Fastlink service will be concluded by the Board as an aspect of the masterplanning prior to the conclusion of the competitive dialogue process.

The status of planning matters are identified in Appendix D.2, with details of the Masterplanning carried out by the Board in Section 7.0 of the ERs. As noted in Section 2.2, above, the Contractor is responsible for gaining and discharging Detailed Planning Approval.

3.4 Live Hospital Site

The Hospital Campus is a live hospital site, and as such will place restrictions on the Contractor in the construction of the Works. Essential 'blue light' and other access routes will require to be unobstructed by the Contractor 24hours per day, every day.

The 'blue light' and other access routes/site constraints are identified in Appendix A.

3.5 Other Projects On-Site

In addition to the ongoing access and operational requirements of the Board to deliver medical and related services, there shall be other construction projects and programmes ongoing on the Hospital Campus at varying times when the Contractor will be constructing the Works. This may include (but not be limited to) works to create a new-neo natal facility, multi-storey car parks and university facilities as well as a variety of site enabling, ongoing maintenance, utilities and demolitions works.

3.6 Site Logistics

Site Logistics shall form a Dialogue Issue during the Bid Period, this will include discussions in respect of both the live hospital site and other projects on-site, with relevant responsibilities, interface protocols, communications plans and emergency/contingent planning to be discussed and agreed with the Board.

Section 4.0 General Design Requirements

The following section provides an overview of the Board's key objectives for the Works. The Contractor's proposals should clearly demonstrate cognisance of these objectives in relation to the design and the construction process. In particular, the operational, functional and equipment issues contained in the Employer's Requirements must, as a minimum standard, be met by the design and construction solutions of the Contractor. Further to this, the Contractor shall ensure the design delivers a solution which indicates acknowledgement and understanding of the types of patients that are planned for the facility.

The Contractor must take cognisance of the following documentation in his design solutions and shall require to demonstrate in his bid return strategies to embrace the ethos of the documentation in the development of the design:

a. Scottish Government's Policy and Design Quality for NHSScotland;

b. The NHS Greater Glasgow and Clyde Design Action Plan;

c. Achieving Excellence in Design Toolkit (AEDET Evolution);

d. Scottish Planning Policy SPP6; and

e. Planning Advice Note 84.

Further, the Contractor shall design the Works to address the following issues:

4.1 **Uses**

4.1.1 Functional Requirements

The design of the Works shall:

a. Function efficiently, effectively and economically;

b. Optimise the Board's operating costs;

c. Demonstrate that the design fully reflects the special needs for each patient group in terms of access, functional relationships and planning. Patient groups are described and their particular requirements are defined in the Clinical Output Specifications in Appendix B and the mandatory and relevant guidance listed in Section 5.1. The facility as a whole should be fully accessible to the widest variety of patient groups, ambulatory, assisted and non ambulatory patients of all ages providing access to specialist services led by medical staff, allied health professionals and nursing staff;

d. Interface easily with other service providers in particular the wider services provided by the Board; and

e. The design shall be able to do this in terms of environment, scale, comfort, privacy, reassurance, style and security.

4.1.2 Human Dignity

To achieve appropriate levels of privacy, the Contractor shall provide Works which allow adequate space around patients. This may include space for relatives to sit with patients, adequate space between chairs, and seating in rest bays along corridors to provide rest places along the route of the patient / visitor journey. The privacy afforded to patients, staff and visitors shall not be compromised by inappropriate or inadequate sound reduction measures in the design or in the build standard.

Sill heights for windows shall enable outward visibility, in particular for children, patients in wheelchairs and in beds. Special consideration shall be given to the needs of the elderly and those with poor sight. Some doors and internal glazed screens shall require vision panels or other glazing systems, which may be obscured or controlled for privacy. The ability to use vision panels to view objects / small children on the other side is desirable.

4.1.3 Functional Relationships

The design shall offer all users of the Works the highest level of efficiency in their operations by way of relationships and adjacencies between functional units. Layouts shall reflect the workflow and logistics inherent in the Clinical Output Specifications in Appendix B; the parameters identified in the Adjacency Matrix; and the requirements of the housekeeping and domestic staff, catering, staff welfare and related management needs.

4.1.4 Work Flows & Logistics

Workflows within and between departments shall be direct and the routes for patients and staff as short as possible. Internal traffic cross-flows which could be inefficient or conducive to the transmission of micro-organisms either through airborne or other means shall be avoided.

The movement of people and the distribution of supplies and waste shall be carefully considered and the circulation routes shall be clear and appropriately sized, with the use of automated material transfer systems where relevant.

4.1.5 Adaptability & Expansion

The design shall consider the needs for departments to be adapted or expanded. This will require a range of approaches to be taken including the allocation of soft space adjacent to clinical spaces. The design shall demonstrate that potential change or expansion has been considered by the provision of adequate space either at the external perimeter and / or between functions and departments.

The structural grid, construction technique, structure, service penetration and engineering services strategy shall demonstrate that the design proposals for expansion, adaptation and flexibility are co-ordinated.

The provision of engineering, telecommunications infrastructure and building services shall be appropriate for the provision of anticipated changes in medical equipment.

4.2 **Spaces**

4.2.1 Space Standards

The Contractor shall provide designs which are efficient, economical and flexible for immediate and future use, and which can be managed efficiently to cope with seasonal and strategic variations in activity.

Appropriate space provision shall be given to circulation, waiting and sub-waiting space for the movement of patients, pedestrians and the storage and transportation of goods.

Space shall be considered to allow informal discussion, therapy and interaction within open and reception areas in the clinical environment, such as consultation and main waiting and reception areas. Consideration shall also be given to making use of open space areas within clinical areas and main circulation routes for 'break-away' space such as corridor recesses and courtyards.

The Contractor shall recognise that patients' and staff's perception of the spaces created may assist with their feeling of belonging and of not being intimidated, and may help with their orientation, mobility, confidence, privacy and their ability to socialise.

4.2.2 Floor Layouts

The design of departmental and unit layouts shall reflect the demand for space defined by occupancy and usage as described in the Clinical Output Specifications and reflected in the Exemplar Design/SoA. Where areas and shape of rooms results in undesirable spaces, the Contractor shall discuss with the Board alternative solutions, which may or may not result in shared space providing a more appropriate environment as well as optimising the available use of space. These may include locker rooms, sitting areas, seminar rooms etc.

4.2.3 Character & Innovation

4.2.4 Excellence for Patients

The design of buildings, external and internal appearance as well as the design of the external works, and landscape can have a positive or a negative effect upon patient care, staff experience at the work place and the way NHS healthcare buildings are perceived. The Contractor shall develop design solutions which by the use of materials, lighting, shape, scale, mass and form of the building elements make a positive contribution to engendering well-being of patients and staff.

4.2.5 Healthcare Excellence

Healthcare buildings should fit within their community and be compatible in design and the use of materials with their neighbourhood and have a strong NHS identity. The Contractor shall develop building design solutions that:

Reinforce the dependability and reassurance that the NHS means to the local community;

Respect their local environment but at the same time make a positive contribution to the urban context that they are in;

Clearly expresses their function in external and internal appearance;

Allows patient diagnostic and treatment areas that can be differentiated in design concept and detail from inpatient areas; and

Reflect that design considerations such as the distribution, size and proportion of windows and the use of materials can reflect the clinical function.

These elements shall be expressed in the scale and mass of the buildings, as well as the disposition of functions.

4.2.6 Architectural Vision

The Contractor shall develop building design solutions, which create an ordered composition of building elements in a stimulating form that successfully combines good standards of space, height, form, scale and use of materials and colours / images with associated functional requirements and its surroundings.

4.2.7 Stimulating Design

The Contractor shall develop building design solutions which create a high quality, good working environment, both externally and internally, which shall provide a reassuring, enjoyable, convenient and safe environment for all patients, their families, visitors and staff. This objective shall not be in conflict with the desire to produce a stimulating design. The Contractor shall meet this objective and shall develop a design which will not date and be capable of coping with future changes in a way that does not destroy the original design vision / concept. Further, the design shall incorporate best practice in terms of aspects of design that positively impact on health and recovery.

4.2.8 Design Innovation

Innovation in design can range from whole concepts of healthcare facilities' planning, distribution of functions etc to detail design of components, materials, spaces, use of technology etc. The Contractor shall develop designs at the concept level which shall translate the NHS modernisation agenda, and new forms of service delivery into new and innovative building solutions.

4.2.9 Recognisable Quality

The Board expects high quality design to match the best national standards of healthcare provision it intends to implement.

Materials shall be substantial and of high quality. They shall be carefully detailed and constructed such that the quality is appreciated throughout the life of the Works. They shall retain their appearance within a compatible maintenance regime. For example, detailing of external materials shall not cause unsightly staining.

The lifecycle plan and design detailing shall allow for replacement of elements in a way that does not impair design quality or service provision. A schedule of required life expectancies of building elements can be found in Section 5.3.

4.3 Citizen Satisfaction

4.3.1 Design Concept

The visual forms shall enhance the sense of place. They shall make best advantage of the environmental qualities of the Works and the wider Site.

The design concept shall be clear, and will not be compromised by the subsequent detailed design development. The design concept shall be complete and well balanced, with all parts relating to the whole.

4.3.2 Scale & Proportion

Appropriate scale and proportions shall reflect the human scale, adjoining urban surroundings and any existing buildings / structures retained on the Site. Plant rooms, lift and stair towers shall express form and function, but they shall not be perceived as dominating and oppressive.

4.3.3 Composition

The composition of the buildings shall be complete, cohesive and well balanced in massing. The visual form shall enhance the Site and sense of place. This can be done in a number of ways including by linkages to surroundings in plan form, expressions in the design of local character and including natural features of the Site in the composition.

The overall form of the buildings shall be designed to demonstrate the special needs of the function of each unit. The design shall clearly express in the form of the buildings the individuality and special nature of parts of the Works, yet the parts should harmonise with the Works and the overall site. The Contractor should give particular consideration to the architectural composition and expression of the following key aspects of the facility;

a. The form of the Adult Acute and Children's Hospital while mutually compatible should have an identifiably distinct character expressed both externally and internally as befits the nature of the patient groups; and

b. The Contractor will be require to ensure that the new Works are consistent with the overall masterplan strategy and with the existing facilities on the site, as such particular consideration should be given to the adjoining neonatal unit (which requires to be co-joined by an abutment) and the provision of a link to the institute of neurological sciences.

4.3.4 Aesthetics

The overall visual form of the buildings shall combine good standards of space, height, form and scale. The form of the buildings shall appeal to the aesthetic senses of patients, visitors and staff as follows:

The lines of the design shall clearly define forms and surfaces of the buildings;

The skyline shall reflect the mass of the buildings but not be out of scale and dominating;

The sky line shall not be monotonous;

The solid forms shall be in scale and have harmonious shapes; and

The interplay of light and shade shall add to the definition of the building form and the balance between solid and glazed elements should be carefully considered.

4.3.5 Colour & Texture

Colour decoration and motifs shall be used to facilitate identity of the Works; and its designated areas / zones and in addition improve wayfinding. It can also be used to create an immediate and distinct 'image' of the Works to visitors, which is interesting and stimulating.

The use of colour shall be co-ordinated and adapted with the lighting to the activities of each area, toned down in certain areas e.g., quiet areas, seminar rooms; but bright and stimulating in others, such as waiting and corridor areas.

The Board shall be entitled to choose the colour scheme in consultation with the Contractor and the Contractor shall liaise with the Board and nominated User groups and other representatives (e.g. BATH – Better Access To Health) in this regard.
An interior designer shall be included in the Contractor's design team to secure a clear co-ordination of the interior materials within the Works, matching the furniture, furnishings and equipment being procured by the Board. The colour scheme should be selected with due regard to integration with the Art Strategy as identified in Section 7.17.

4.4 Internal Environment

4.4.1 Quality Environment

The design of the Works shall create a high quality, good working environment, both externally and internally which will provide a reassuring, enjoyable, convenient and safe environment for all patients, their families, visitors and staff.

4.4.2 Light & Colour

The design shall provide quiet, comfortable areas with pleasing outlook easily accessible from clinical areas where patients and their families / visitors can "escape" from the clinical environment. Such areas may facilitate informal discussions with health professionals in the future, and be equipped for play / recreation. Where possible natural sunlight is to be brought into areas. The Contractor shall liaise with the Board and nominated User groups and other representatives (e.g. BATH – Better Access To Health) with regard to light and colour aspects.

4.4.3 Views

The Works shall provide quiet, comfortable areas with pleasing outlooks and easy access from clinical areas.

4.4.4 Internal Wayfinding

Design solutions shall incorporate an integrated, comprehensive wayfinding strategy that enables patients, visitors and staff to self-navigate with ease and lack of stress throughout the buildings.

The wayfinding strategy shall be designed to meet the needs of patients and visitors but routes shall be clearly defined to ensure that parts of the buildings that are restricted to staff are not used as short cuts by patients and visitors. The use of enclosed internal courtyards as an integral part of a route shall be considered. The Contractor shall liaise with the Board and nominated User groups and other representatives (e.g. BATH – Better Access To Health) with regard to the use and detailing of internal wayfinding.

Internal signage shall be easily understood and consistent throughout the journey from the entrance to the department reception and on to rooms. It shall not create clutter and the use of pictograms and graphic art should be considered.

Proposals shall be developed which acknowledge the multi-sensory process used in wayfinding and which address the need of people with impairment in touch, smell, sight or sound. The proposals should be developed with due regard to the requirements of the NHS Identikit guidance.

4.4.5 Internal Spaces

All internal spaces shall be well planned and appropriate within clinical areas.

Some spaces shall be designed to encourage social interaction for patients, visitors and staff.

Public spaces shall be used to integrate the various parts of the buildings, and shall be designed to avoid being a space joined by long, narrow corridors.

4.5 Urban & Social Integration

4.5.1 The Contractor should recognise that the design of the new hospital offers the opportunity for a responsive design which addresses the requirement for the sharing of Works with the wider community for the mutual benefit of both the functioning hospital campus and the local community at large.

Embodied in this approach will be the Travel Plan which addresses issues of local and regional access to the new Works in terms of

a. Car parking provision;

b. Public Transport Nodes;

c. Distance to Local Amenities;

d. Pedestrian routes and links;

e. Facilities for cyclists; and

f. Segregation of emergency servicing and visitor access routes.

The Contractor's objective should be to create an easily accessible healthcare facility which incorporates a Green Transport Strategy, segregates traffic flows and prioritises pedestrian routes. The strategy will require to be jointly developed by the Contractor in conjunction with the Board and Glasgow City Planning Authority taking cognisance of the Board's site-wide masterplan requirements.

Given the nature of the patient group, the children's hospital shall be extensively accessed by family groups and parents at varying time of night and day. Accessibility and amenity in design should take cognisance of this consideration.

The Contractor should consider opportunities in the building for third party development of support facilities such as retail outlets, cafes, health clubs, sports injury clinics, gymnasiums etc.

4.5.2 Sense of Place

The Works shall be designed to compliment and enhance the quality of the design in the locality in which it is sited. It shall create a welcoming, inclusive and vibrant environment, and shall enable easy access by the communities and groups who will use it. It shall be seen as a leading edge community resource reflecting the objectives of a modern NHS in the regeneration of healthcare facilities.

The Works shall be organised to establish a continuity of building frontage and a clear definition of public and private spaces. The viewing of service areas or more “industrial” looking parts of the Works from public entrances or from adjoining public spaces shall be avoided.

4.5.3 Good Neighbour

The Contractor shall ensure they are considered as a ‘good neighbour’ throughout design and construction periods. It shall add value to the neighbourhood, not detract nor be a nuisance. The Contractor shall register with and fully comply with the requirements of the Considerate Constructors Scheme. All sites registered with the Scheme are monitored by an experienced industry professional to assess their performance against the eight point Code of Considerate Practice which includes the categories Considerate, Environment, Cleanliness, Good Neighbour, Respectful, Safe, Responsible and Accountable.

The three main areas that the Scheme’s Code covers are:

a. The Environment: Registered sites should do all they can to reduce any negative effect they have on the environment. They should work in an environmentally conscious, sustainable manner;

b. The Workforce: Registered sites should provide clean, appropriate facilities for those who work on them. Works should be comparable to any other working environment;

c. The General Public: Registered sites should do all they can to reduce any negative impact they may have on the area in which they are working. Sites should aim to leave a positive impression on those they affect.

The Contractor shall provide Works which contribute to improving civic design, sensitive to its relationship with its surroundings, public transport and overall visual impact.

4.5.4 Neighbourhood & Community

The building height, volume and skyline shall relate well to the surrounding environment.

The design shall reflect the importance of the project in the context of community healthcare in the heart of an urban conurbation. Attention shall be paid to detail in the elevations, to ensure that blandness and lack of relief is avoided.

The form of development shall follow any changing topography across the Site, neighbouring properties, existing streetscape and landscape. The design of the Works shall be sensitive to and maximise existing Site features. It is envisaged that the buildings should compliment other new building developments in the area.

4.5.5 Site Fit

New buildings, parking areas, other infrastructure and services shall be located with regard to the existing landscape and topography. Amenity space shall be planned around the buildings at appropriate places.

The Contractor shall ensure that the design of the Works shall take account of the ecological and landscape features of the Site and maximise the retention of trees. There shall be a clear programme for future environmental improvements e.g., an arboricultural strategy for tree management and replanting, dedicated access to external grounds by patients, visitors, local communities and staff.

The design of the Works shall identify areas of the Site as possible expansion zones.

Suitable provision shall be made for refuse storage including provision of appropriate refuse bins and recycling facilities. Full details to be submitted to, and approved by the planning authority prior to the commencement of works

4.5.6 Hard & Soft Landscaping

The landscaping scheme shall be of a high quality. It shall assist in knitting the Works into its surroundings, and provide an interlinked network of attractive public spaces for amenity and circulation for use by patients, staff and visitors. The soft landscape design and choice of species shall be sympathetic to the character of the existing parkland landscape.

External hard and soft landscaping (including courtyards) shall be designed for therapeutic use and provide patient access. The landscape scheme shall facilitate security of pedestrians and avoid ‘No-Go’ areas. The design shall contribute to improving the environment of the local community.

Both hard and soft landscaping design require to specifically accommodate the needs of children and family groups, particularly in the areas adjacent to/around the children’s hospital.

Courtyards adjacent to the amenity area require to be accessible to patients, visitors and staff, with the Contractor to co-ordinate fire escape solutions to support this function.

A comprehensive and integrated landscape strategy taking into account the existing landscape features shall be developed. A clear strategy shall be developed for appropriate formal and informal treatment of public and private areas.

For further detailed landscaping scheme requirements refer to Sections 7.13 and 7.14.

4.6 AEDET and ASPECT

Healthcare building design frequently involves complex concepts which are difficult to measure and evaluate. In order to assist both the Board and the Contractor, the Board expects the Contractor to utilise the Achieving Excellence Design Evaluation Toolkit, more commonly known as AEDET Evolution and the associated supplementary tool ASPECT which are recognised as the exemplars of Design Quality Indicator (DQI) tools.

AEDET and ASPECT are to be used to assist in achieving the appropriate level of project design management and will be specifically directed towards achieving excellence in design rather than ensuring compliance with legislation, regulation and guidance. The toolkit poses a series of clear, non-technical statements, encompassing the three key areas of Impact, Build Quality and Functionality as a tool for evaluating the quality of design in healthcare buildings which have been evolved from sources including the Commission for Architecture and the Built Environment (CABE) and the Construction Industry Council (CIC) to establish an industry-wide framework for assessing design.

AEDET shall be used at various stages during the design – as the level of detail of the information available increases it should be possible to respond to more of the statements in the tool. As a minimum AEDET assessments will take place on the return bids as well as in preparation for FBC.

To complement AEDET Evolution, the Department of Health (England) Estates and Facilities Directorate has developed the ASPECT toolkit. ASPECT stands for A Staff and Patient Environment Calibration Tool and is based on a database of over 600 pieces of research. That research deals with the way the healthcare environment can impact on the levels of satisfaction shown by staff and patients and on the health outcomes of patients and the performance of staff. This research and the ASPECT toolkit itself are set out under 8 headings. When used to support AEDET Evolution ASPECT enables the user to score the Staff and Patient Environment Heading of AEDET Evolution in a more detailed, accurate way.

Section 5.0 General Design & Construction Requirements

5.1 Minimum Design & Construction Standards

5.1.1 NHS Publications

General

5.1.1.1 The Board has considered the documentary advice and guidance provided by Health Facilities Scotland and the Facilities Directorate of the Department of Health in relation to Health Building Notes ("HBN"), Health Technical Memoranda ("HTM"), Fire Practice Notes ("FPN") and other National Health Service published material.

5.1.1.2 The Contractor in carrying out of the Works shall comply with the requirements of the documents listed in *Table 2 – NHS Mandatory Documentation* in Section 5.1.2. Specific statements of compliance form an aspect and element of the bid return and evaluation process and requirements, with the requirement for bidders to clarify their approach during the bid period as an aspect of the dialogue process.

5.1.1.3 The Contractor in carrying out the Works shall have regard to and take into consideration the requirements of the documents listed *Table 3 - NHS Guidance Documentation* in Section 5.1.3. Specific statements of compliance form an aspect and element of the bid return and evaluation process and requirements, with the requirement for bidders to clarify their approach during the bid period as an aspect of the dialogue process.

5.1.1.4 Documents listed in *Tables 2 and 3* (together part of "NHS Publications") are deemed to include all volumes, supplements and any other associated requirements, unless specific volumes, parts or the like are specifically noted or noted as excluded.

5.1.1.5 Any reference to HTM/HBN is deemed to include SHTM/SHPN. The requirements of SHTM/SHPN shall take precedence over HTM/HBN unless expressly required otherwise by the Board and noted in *Table 2 or 3.* Presently *Tables 2 and 3* include reference to HTMs in relation to services systems. It is the intention of the Board that the new SHTMs in these areas, due for release by HFS late April/early May 2009, will be adopted and require to be complied with, as shall other SHTMs issued during the procurement process (subject to 5.1.9 below) – this to be clarified by the Board during the bid period. Current draft documentation is marked in *Tables 2 and 3* in blue shading.

5.1.1.6 In the event of any conflict (including differing requirements or interpretations) between the requirements of the documents listed in *Table 2 or Table 3* and the requirements of building control officers, such conflict should be highlighted to the Board for agreement and resolution. The Contractor shall notify the Board in writing of any such conflict as soon as he becomes aware of same;

5.1.1.7 In the event of any conflict between the requirements of the documents listed in *Table 2 or Table 3* or any other drawn or written information issued by the Board and the Schedule of Accommodation (SoA) information issued by the Board in this ITPD, the SoA identifies the minimum area requirements of the Board (in relation to room sizes).

5.1.1.8 In the event of any conflict between the requirements of the documents listed in *Table 2 or Table 3* and any written or drawn information issued to the Contractor by the Board in this ITPD, the information issued by the Board shall take precedence.

5.1.1.9 All references in these Employer's Requirements to NHS Facilities Scotland Requirements, building and engineering standards, Building Regulations, legislation,

Statutory Requirements, Codes of Practice, Department of Health publications, NHS Publications and other published guidance shall be deemed to mean those in place at the date of signing the construction contract. Any date reference in *Table 2 or Table 3*, therefore, may be replaced/read as that in place at the date of signing the construction contract.

5.1.1.10 Except as noted in 5.1.7 or 5.1.8 above, the Contractor shall provide Works which comply at all times with the requirements of *Table 2, Table 3* and the Additional Guidance identified at Section 5.1.4.

5.1.2 **NHS Mandatory Documentation**

In relation to the architectural design, structural design, and services design of the new buildings comprised in the Works, the documents listed in the following *Table 2* below set out that guidance which the Board considers to be mandatory.

Document	Title
CEL 25	Fire Safety policy for NHS Scotland 2008
SHTM 81	Fire Precautions in new hospitals Version 3
SHTM 82	Alarm and detection systems Version 2
SHTM 82 SUPP A	Automatic fire control systems and voice alarm systems
SHTM 83	Fire safety in healthcare premises - general fire precautions Version 2
SHTM 85	Fire precautions in existing hospitals Version 3
SHTM 86	Fire risk assessment Part 2 Healthcare Premises Version 4
SHTM 87	Textiles and furniture Version 2
HTM 05 – 01	Firecode – Fire safety in the NHS
HTM 05 – 02	Firecode – Fire safety in the NHS
HTM 05 – 03 (incl.)	Firecode – Fire safety in the NHS
HSANs	All published Health and Safety Action Notices
NHSE 10	Cubicle Rails
NHSE HN04	Curtain Tracks
NHSE HN03	Centre Pivot Window
SAN05/08	Flooring Materials
SN(01)01	Cubicle Rail
HVHNs	All published High Voltage Hazard Notices
SHTM	EnCOde – making energy work in healthcare
	EnCOde resource material
CEL 18	Healthcare Associated Infection: SHFN 30 and HAI SCRIBE Implementation Strategy
	HAI SCRIBE
SHFN 30	Infection Control in the built environment:design and planning.

Document	Title
	Access Audit Survey Toolkit V1
	Access Audit Checklist V1
	Fully Accessible Toilets
	SHFN 14 Disability Access
	SHFN Access audits of primary healthcare facilities
SFPN 3	Escape bed lifts Version 2
SFPN 4	Hospital main kitchens Version 2
SFPN 5	Commercial enterprises on hospital premises Version 2
HBN 04-01	Adult in-patient Facilities
HBN 00-04	Common activity spaces: circulation areas
HBN 15 – 03	Hospital helipads
SHTM 00	Scottish Health Technical Memorandum 00: Best practice guidance for healthcare engineering
SHTM 2005	Building Management Systems Parts 1 – 4
HTM 06-01 Part A	Part A Elec Services Supply and Distribution
HTM 06-01 Part B	Part B Elec Services Supply and Distribution
Draft for Consultation SHTM 06-01 Part A	Part A Elec Services Supply and Distribution
Draft for Consultation SHTM 06-01 Part B	Part B Elec Services Supply and Distribution
SHTM 2007	Scottish Health Technical Memorandum 2007 (Part 3 of 4): Validation and verification Electrical services: supply and distribution
SHTM 2007	Scottish Health Technical Memorandum 2007 (Part 4 of 4): Operational management Electrical services: supply and distribution
SHTM 2009	Pneumatic Tube Systems Parts 1 – 2
SHTM 2010	Sterilization Parts 1 – 6
SHTM 2011	Emergency Electrical Services Parts 1 – 4
SHTM 2014	Abatement of Electrical Interference Parts 1 – 4
SHTM 2015	Bedhead services
	Part 1 Overview and management responsibilities
	Part 2 Design considerations
	SHTM 2015 forms
SHTM 2020	Electrical safety code for low voltage systems
	Volume 1 Operational management
	SHTM Volume 1 forms
	HTM Volume 2 forms

Document	Title
SHTM 2021	Electrical safety code for high voltage systems
	Part 1 Overview and management responsibilities
	Part 2 Operational management
	SHTM 2021 forms
HTM 02-01 Part A	Medical gas pipeline systems : Part A
HTM 02-01 Part B	Medical gas pipeline systems : Part B
Draft for Consultation SHTM 02-01 Part A	Medical gas pipeline systems : Part A
Draft for Consultation SHTM 02-01 Part B	Medical gas pipeline systems : Part B
SHTM 2022 March 2004	Supp 1 Dental compressed air and vacuum systems
	SHTM 2022 forms
SHTM 2023	Access and accommodation for engineering services
	Part 1 Overview and management responsibilities
	Part 2 Good practice guide
SHTM 2024	Lfts
	Part 1 Overview and management responsibilities
	Part 2 Design considerations
	Part 3 Validation and verification
	Part 4 Operational management
	SHTM 2024 forms
HTM 03-01	Specialised Ventilation for Healthcare Premises
HTM 03-01 Part B	Specialised Ventilation for Healthcare Premises Part B
HTM 03-01 Part A	Specialised Ventilation for Healthcare Premises Part A
Draft for Consultation SHTM 03-01 Part A	Specialised Ventilation for Healthcare Premises Part A
Draft for Consultation SHTM 03-01 Part B	Specialised Ventilation for Healthcare Premises Part B
	SHTM 2025 forms
SHTM 2027	Hot and cold water supply, storage and mains services
	Part 1 Overview and management responsibilities
	Part 4 Validation and verification
HTM 04-01 Part A	Control of Legionella...drinking systems Part A
HTM 04-01 Part B	Control of Legionella...drinking systems Part B
Draft for Consultation SHTM 04-01 Part A	Control of Legionella...drinking systems Part A
Draft for Consultation SHTM 04-01 Part B	Control of Legionella...drinking systems Part B

Document	Title
SHTM 2030	Washer disinfectors
	Part 1 Design considerations
	Part 2 Operational management
	Part 3 Validation and verification
SHFN	Access Audit Survey Toolkit V1
SHFN	Access Audit Checklist V1
SHFN	Fully Accessible Toilets
SHFN 14	Disability Access
SHFN	Access audits of primary healthcare facilities
SFPN 3	Escape bed lifts Version 2
SFPN 4	Hospital main kitchens Version 2
SFPN 5	Commercial enterprises on hospital premises Version 2
HBN 00 -02	Sanitary spaces
HBN 04-01	Adult in-patient Facilities
HBN 00-04	Common activity spaces: circulation areas
HBN 15 – 03	Hospital helipads
SHTM 00	Scottish Health Technical Memorandum 00: Best practice guidance for healthcare engineering
SHTM 2005	Building Management Systems: Parts 1 – 4 (incl)
HTM 06-01 Part B	Part B Elec Services Supply and Distribution
HTM 06-01 Part A	Part A Elec Services Supply and Distribution
SHTM 2007	Scottish Health Technical Memorandum 2007 (Part 3 of 4): Validation and verification Electrical services: supply and distribution
SHTM 2007	Scottish Health Technical Memorandum 2007 (Part 4 of 4): Operational management Electrical services: supply and distribution
SHTM 2009	Pneumatic Tube Systems: Parts 1 – 2 (incl)
SHTM 2010	Sterilization: Parts 1 – 6 (incl)
SHTM 2011	Emergency Electrical Services: Parts 1 – 4 (incl)
SHTM 2014	Abatement of Electrical Interference: Parts 1 – 4 (incl)

Document	Title
SHTM 2015	Bedhead services
	Part 1 Overview and management responsibilities
	Part 2 Design considerations
	SHTM 2015 forms
SHTM 2020	Electrical safety code for low voltage systems
	Volume 1 Operational management
	SHTM Volume 1 forms
	HTM Volume 2 forms
SHTM 2031	Clean steam for sterilization
SHTM 2035	Mains signalling
	Part 1 Overview and management responsibilities
	Part 2 Design considerations
	Part 3 Validation and verification
SHTM 2040	The control of legionellae in healthcare premises – a code of practice
	Part 1 Overview and management responsibilities
	Part 4 Validation and verification
	Part 5 Good practice guide
	Part 6 supplementary guidance applicable to intermittently used healthcare premises
	SHTM 2040 forms
HTM 08-01	Acoustics
MEIGaN	Medical Electrical Installation Guidance Notes (MEIGaN)
SHTM 54	User Manual
SHTM 55	Windows
SHTM 56	Partitions
SHTM 57	Internal glazing
SHTM 58	Internal doorsets
SHTM 59	Ironmongery
SHTM 60	Ceilings
SHTM 61	Flooring
SHTM 62	Demountable storage systems
SHTM 63	Fitted storage systems
SHTM 64	Sanitary assemblies

Document	Title
SHTM 66	Cubicle curtain track
SHTM 67	Laboratory fitting out systems
HTM 68	Duct and Panel assemblies
SHTM 69	Protection
Draft for Consultation SHTM 87	Textiles & Furniture

Table 2 – NHS Mandatory Documentation

5.1.3 **NHS Guidance Documentation**

In relation to the architectural design, structural design, and services design of the new buildings comprised in the Works, the documents listed in the following *Table 3* set out that guidance which the Board considers to be guidance.

Document	Title
	NHSSCOTLAND National Cleaning Services Specification
SFPN 6	The prevention and control of deliberate fire-raising in NHS Scotland healthcare premises Version 3
SFPN 10	Laboratories on hospital premises
SFPN 11	Reducing unwanted fire signals in healthcare premises
SHGN	Magnetic Resonance Imaging
SHGN	"Safe" hot water and surface temperatures
SHGN	Static discharges
SHGN	Structured cabling for IT systems
SHTN 2	Domestic Hot and Cold Water Systems for Scottish Health Care Premises
SHTN 4	General Purpose Estates and Facilities Model Safety Permit-to-Work System
SHTN 5	The Operation and Management of Emergency Electrical Generators in Scottish Healthcare Premises
SHTN 6	The Safe Operation and Maintenance of Thermostatic Mixing Valves
SHPN 03	General Design Guidance
SHPN 06 Part 1	Facilities for diagnostic imaging and interventional radiology
SHPN 08	Facilities for rehabilitation services
SHPN 13 Part 2	Decontamination Facilities: Local Decontamination Units
SHPN 20	Facilities for mortuary and post mortem room services
SHPN 22	Accident and emergency facilities for adults and children

Document	Title
SHPN 27	Intensive care unit
SHPN 28	Facilities for cardiac services
SHPN 35	Accommodation for people with mental illness
SHPN 52	Accommodation for day care: Day surgery unit
SHPN 52	Accommodation for day care: Endoscopy unit
SHPN 52	Accommodation for day care: Medical investigation and treatment unit
SHPN 54	Facilities for cancer care centres - design and briefing guide
Draft for Consultation SHPN 06 Part 2	Facilities for Diagnostic Imaging
Draft for Consultation SHPN 23	Hospital Accommodation for Children and Young People
Draft for Consultation SHPN 28	Facilities for Cardiac Services
Draft for Consultation SHPN 57	Facilities for Critical Care
	Wayfinding: Effective Wayfinding and Signing Systems guidance for healthcare
	Handover checklist for buildings
HBN 04 Supp	Isolation facilities in acute settings
HBN 06	Facilities for diagnostic imaging and interventional radiology
HBN 06 Vol 2	PACS and specialist imaging
HBN 06 Vol 3	Extremity and open MRI
HBN 08	Facilities for rehabilitation services
HBN 10	Catering department
HBN 12	Out-patients department
HBN 22	Accident and emergency facilities for adults and children
HBN 23	Hospital accommodation for children and young people
HBN 26	Operating Departments – Facilities for Surgical Procedures
HBN 28	Facilities for Cardiac Services
HBN 29	Accommodation for pharmaceutical services
HBN 37	In-patient facilities for older people
HBN 40 Vol 1	Common activity spaces: public areas
HBN 40 Vol 2	Common activity spaces: treatment areas
HBN 40 Vol 3	Common activity spaces: staff areas

Document	Title
HBN 45	External works for health buildings
HBN 51	Accommodation at the main entrance of a District General Hospital
HBN 52 Vol 1	Accommodation for day care: Day surgery unit
HBN 52 Vol 1 Supp 1	Review of schedules of accommodation
HBN 52 Vol 3	Accommodation for day care: Medical investigation and treatment unit
HBN 54	Facilities for cancer care centres
HBN 57	Facilities for critical care
HBN 00 -02	Sanitary spaces
HBN 00 – 07	Resilience planning for the healthcare estate
HBN 07 – 01	Satellite dialysis units
HBN 07 – 02	Main renal units
HBN 09 – 02	Maternity care facilities
HBN 14 – 01	Pharmacy and radiopharmacy
HFN 05	Design against crime: a strategic approach to hospital planning (now archived)
NHS Estates Improving the Patient Experience	Friendly healthcare environments for children and young people
NHS Estates Improving the Patient Experience	Welcoming Entrances and reception areas
NHS Estates Improving the Patient Experience	The Art of Good Health : Using visual arts in healthcare
NHS Estates Improving the Patient Experience	The Art of Good Health : A practical guide

Table 3 - NHS Guidance Documentation

5.1.4 **Additional Guidance**

5.1.4.1 Further to the requirement noted in Section 2.2, that the Contractor shall comply with all Law and Consents, and the requirements in relation to NHS Mandatory Documentation and NHS Guidance Documentation above, the Contractor shall also comply with the standards and documents listed below.

a) Health and Safety Legislation, including Construction (Design and Management) Regulations 2007;

b) The Technical Standards complying with the Building Standards (Scotland) Regulations 1990 as amended by all subsequent Amendment Regulations;

c) Disability Discrimination Act 1995;

d) Current British Standards, European Standards, and Codes of Practice, as appropriate;

e) Strathclyde Fire Brigade and the Glasgow City Council's Fire Officer requirements;

f) The Board's Approved Codes of Practice, Procedure and Policy documents as listed in Appendix G;

g) Control of Substances Hazardous to Health;

h) Health Department Letters (or Management Executive Letters) as appropriate published by SEHD;

i) NHS QIS (Quality Improvement Scotland) 2003;

j) NHS Model Engineering Specifications;

k) The Building (Scotland) Act 2003;

l) The Building (Scotland) Regulations 2004;

m) Requirements of the utilities companies;

n) Building Research Establishment Digest Recommendations;

o) Local Bye-Law and Regulations;

p) Scottish Centre for Infection and Environmental Health guidance / recommendations;

q) All other bodies and authorities having jurisdiction;

r) Secure by Design;

s) The Ionising Radiations Regulations 1999 (IRR99);

t) The Radioactive Substances Act (1993);

u) Medical and Dental Guidance Notes: A good practice guide on all aspects of ionising radiation protection in the clinical environment, Institute of Physics and Engineering (IPEM), York, 2002;

v) Various related to the additional security required re use of radioactive materials e.g. IRR99, RSA93, NHS Security Management guidance note 001/2004;

w) Guidelines for the use of PET-CT in Children (UK PET-CT Advisory Board), British Nuclear Medicine Society (BNMS), London, 2008;

Healthcare interpretation of IEE Guidance Note 7 (Chapter 10) and IEC 60364-7-710 for Electrical Installations in Medical Locations. Annex to MEIGaN, Leeds, June 2005;

x) Releasing Time To Care (RTTC): The Productive Ward (NHS Innovations, 2008);

z) Delivering Quality & Value, Institute for Modernisation & Improvement;

aa) The Internal Environment: Evaluation of the King's Fund, Enhancing the Healing Environment Programme (NHS Estates, 2004);

bb) Lighting and colour for hospital design, Dalke et. Al. (NHS Estates, 2004);

cc) The role of hospital design in the recruitment, retention and performance of NHS nurses in England, CABE, July 2004;

dd) Notes for Guidance on the Clinical Administration of Radiopharmaceuticals and Use of Sealed Radioactive Sources, Administration of Radioactive Substances Advisory Committee (ARSAC);

ee) Provision of Paediatric Radionuclide Imaging Services, British Nuclear Medicine Society (BNMS), London, 2003;

ff) Published papers on operational radiation safety e.g. Zanzonico P et al, Operational Radiation Safety for PET-CT, SPECT-CT and cyclotron facilities. Health Physics 2008;

gg) Standards for Intensive Care Units, A Joint Document for the Intensive Care Society and the Intercollegiate Board for Training in Intensive Care Medicine, May 2006;

hh) Leather P, Pyrgas M, Beale D and Lawrence C. Windows in the Workplace: Sunlight, View and Occupational Stress. Environment and Behaviour 1998; 30: 739 – 762;

ii) Leslie RP. Capturing the Daylight Dividend in Buildings: Why and How? Building and Environment 2003; 38: 381 – 385;

jj) Heerwagen J. Green Buildings, Organizational Success and Occupant Productivity. Building Research and Information 2000; 28: 353 – 367;

kk) National Overview – Adult Renal Services (March, 2003) NHS Quality Improvements Scotland;

ll) Adult Renal Services (Feb, 2002) Clinical Standards Board for Scotland;

mm) Treatments of Adults & Children with Renal Failure – Standards & Audit Measures, 3rd Edition, Renal Association (August, 2002);

In addition the renal COS notes that water treatment should reach a minimum of the following standards:

nn) The higher European Pharmacolela (EP) XV1 standard :'Water for diluting concentrated haemodialysis solutions';

oo) ISO 13959: 'Water for haemodialysis and related therapies' or
AAMI (Association for the Advancement of Medical Instrumentation) standards; and

pp) European Renal Association Best Practice Guidance – 4th Edition 2007. NB New guidelines are due in 2009 and should be considered at that time.

5.1.4.2 The Contractor shall provide to the Board at Completion a certificate confirming that the Works comply with the requirements of NHS Scotland Firecode.

5.1.4.3 The Contractor shall provide all fixed and portable fire fighting equipment to comply with statutory requirements and the requirements and recommendations of NHS Scotland Firecode.

5.1.4.4 The Contractor shall ensure that the Works comply with the relevant requirements of Building Better Healthcare Volume 3 (published by NHS Estates); except insofar as there are NHS Scotland publications, which shall take precedence over the respective elements of Building Better Healthcare.

5.2 **Hierarchy of Standards**

5.2.1 Where there is any conflict between two or more documents, the more onerous standard shall be complied with by the Contractor, at no additional cost to the Board.

5.2.2 NHS Scotland standards shall take precedence over equivalent NHS England & Wales standards unless the NHS England & Wales standard is specifically identified in *Table 2 or Table 3*.

5.2.3 In certain instances, NHS Publications include a number of options or alternative solutions. Where the Board has defined their preference in *Table 2, Table 3* or in these Employer's Requirements the Contractor shall adopt these preferences as a mandatory requirement. As is noted in 5.1.1.2 and 5.1.1.3, the Contractor shall identify their interpretation and choice (of any options within documents) in NHS Publications during the bid period (to which the Board will review and respond) with compliance statements required in their bid return.

5.2.4 While the Board has placed a clear obligation on the Contractor in relation to NHS Publications, it also wishes to acknowledge that in certain cases the subject matter, guidance and advice included therein has been further developed and improved since the date of publication. While applying the foregoing as a base position, the Board does not wish to limit the use of current best practice or innovation in relation to the adoption of design standards. Consequently, the Board therefore wishes the Contractor to actively engage the Board in an on-going dialogue during the design process in order for the Board to review and agree to any proposed alternatives.

5.2.5 The Board considers NHS Publications reflect minimum standards and any alternatives proposed by the Contractor shall provide an equivalent or enhanced level of service and quality.

5.2.6 Further to the statements above in relation to NHS Publications, it should be noted that the Schedules of Accommodation (SoA) in Appendix C take precedence with regard to room sizes. The room sizes therein must be provided by the Contractor as a minimum requirement.

5.2.7 Further to the statements above in relation to NHS Publications, the following hierarchy of other design related documents shall apply (in order of precedence):

a. 1:50 drawings;

b. Room Data Sheets; and

c. Equipment Lists.

5.3 Life Expectancies & Lifecycle Requirements

5.3.1 The buildings, including building services components, shall be designed with materials, components and techniques that are readily available, reliable, sustainable and easily maintainable in use. The Board supports buildings constructed of proven technology components, with high life expectancy, leading to minimum cost in use.

5.3.2 Good Industry Practice for a design life at Completion for the elements listed below shall as a minimum be as indicated in the table below:

Table 1 – Component Life Expectancies

Building Element	Expectancy
Structure, including substructure	70 years
Floor structure	70 years
Roof structure	70 years
Drainage and below ground civil engineering infrastructure	70 years
External walls	45 years
External openings, windows, doors and curtain walling	25 years
Roof finishes	40 years
External Wall finishes	25 years
External hard surfaces (inc roads/carparking/footpaths etc)	Not less than 20 years to first maintenance
Internal partitions including openings	30 years
Internal doors	15 years
Internal finishes	15 years
Internal fixtures and fittings	15 years
Ironmongery	15 years
Engineering plant Volume B	CIBSE Guide
Engineering services distribution systems Volume B	CIBSE Guide

5.3.3 The Contractor shall demonstrate that the theoretical design life proposed for any element will be achieved.

5.3.4 Materials and components forming part of the Works, which require maintenance and replacement within the life of the Works, shall be selected, located and fixed in such a way as to minimise future inconvenience, disruptions and to avoid temporary closure of the Works.

5.3.5 Lifecycle Costs

5.3.5.1 It is a requirement of the Bid that a detailed Life Cycle Cost Plan (LCCP) be provided for the new facilities – it is envisaged that 3no.separate LCC Plans will be required for the project;

a. Acute Adult Hospital;

b. Childrens Hospital; and

c. Laboratory Block.

NB – it is assumed that External Works and FM/Energy Centre etc buildings will be separately identified and incorporated into the Acute Adult Hospital LCCP.

5.3.5.2 It is a requirement that the LCCP's be produced in accordance with the methodology as detailed in the following documentation;

a. BS ISO 15686 – 5 2008; Building & Construction Assets – Service Life Planning – Part 5 – Life Cycle Costing; and

b. Standardized Method of Life Cycle Costing for Construction Procurement

5.3.5.3 LCCP submissions to follow the formats as detailed in the above documentation, utilising the following base criteria:

Table 2 – Life Cycle Cost Plan component elements

REF	ELEMENT	DESCRIPTION	REQUIREMENT
1.0	Design Life	n.a.	60 years
2.0	LCCP Duration	Period to be considered within LCCP (NB – excluding Construction Period)	30 and 60 years
3.0	Discount Rate	NVP rate	3.5%
4.0	Base Date	Base Date for Costs	Acute & Childrens Hospitals – 1Q2015 Laboratory Block – 1Q2012
5.0	Client On Costs	Bidders to **exclude** Client On Costs to LCCP values	n.a.
6.0	LCCP inclusions	Schedule of LCC Information and Assumptions	
6.1	LCCP Summary Sheet	Elements for inclusion in Life Cycle Cost Plan	All as detailed in Standardized Method Appendix F.3&4, with the following **exclusions:** 1.3 – Client Definable Costs 2.7 – Client Definable Costs 3.1.2 – Internal Cleaning 3.1.3 – Specialist Cleaning 3.3. – Administrative Costs 3.4 – Overhead Costs 3.5 – Taxes 3.6 – Client Definable Costs. 4.17 Occupancy Costs 5.3 – Reinstatement & Dilapidations 5.4 – Client Definable Costs

6.2	LCCP Data Sheets		Data sheets to itemise: • Component Description • Work Description • Quantity • Unit • Component Cost Rate (£) • % Allowance of Cost Rate for Replacement • % Allowance for Replacement • Replacement Factor • Life Expectancy of Component • Number of Replacements • Cost per Replacement (£) • Total Cost of Replacement (£)
			All above elements to be provided in BCIS Elemental format
6.3	FM Data Sheets (Hard FM only)	Bidders to allow for the following FM Services: • Minor replacements, repairs & maintenance costs • Unscheduled repairs, replacement & maintenance costs • Grounds Maintenance	Data sheets to itemise: • Management Costs • Staff/Contracted Costs • Materials • Equipment Bidders to **exclude** Client On Costs to FM Services values

5.3.3.4 Although the Contractor will not be involved in the provision of FM Services, the proposed Design will impinge on the Boards operation of the facilities, and to this end the evaluation of the Bidders overall submission will take into account proposals to minimise the potential operating costs;

5.3.3.5 Bidders should therefore indicate where measures in relation to the following criteria have been utilised

a. 'Spend to Save' specification enhancement;

b. Design detailing;

c. Controls;

d. Standardisation; and

e. Modular construction.

5.3.3.6 All Innovation & Sustainability initiatives proposed by the Bidder, should be supported by a full Lifecycle Cost Plan as detailed above, and include;

a. Items as detailed in Section 6.1/2 – of the above LCC table;

b. Projected Energy & Carbon savings;

c. Payback period; and

d. Items as detailed in Section 6.1/3 – FM Data Sheets of the above LCC table.

5.3.3.7 The Bidders attention is drawn to the BREAAM LCC requirements, which need to be encompassed as part of the overall LCCP submission – all as detailed in Appendix U.

5.3.3.8 In connection with the above, and for bid comparison purposes, Energy consumption/savings calculations should utilise the following base cost and associated allowances;

a. Electrical consumption – 10p / KwH;

b. Gas consumption – 3.5p / KwH;

c. Oil consumption – 41p / litre;

d. Water consumption – £2.20 / m3;

e. Waste material disposal (bagged) – £60/ton;

f. Carbon production/reduction data to be provided to support above proposals; and

g. Payback periods to be provided.

5.4 Integration of Design

The Contractor is responsible for the integration of the various aspects and elements of the design of the Works.

5.4.1 Architectural / Structural Interface

5.4.1.1 Structural floors shall be designed to have penetrable zones co-ordinated with the modular framework for partitions and services.

5.4.1.2 Structural timber floors shall not be permitted.

5.4.1.3 Columns shall be located in-so-far, as is reasonably practical to coincide with corridor walls in order to minimise intrusion into rooms or corridors. The relationship of column ducts and walls shall permit clear internal room surfaces and not obstruct equipment or fittings.

5.4.1.4 As far as practical, the walls to vertical service shafts shall be non-load bearing and therefore maximising opportunity for future services installation, alteration and maintenance.

5.4.1.5 The elevation design shall facilitate distribution of services at the building perimeter.

5.4.2 **Integration with Engineering Services**

5.4.2.1 Internal walls, partition systems, ceiling voids and service risers shall be capable of integrating services, e.g. wiring, plumbing, medical gases and service terminals as required without detriment to the performance of any building services and other Works performance criteria such as fire resistance or acoustic properties. Services shall be co-ordinated and a satisfactory means of maintenance access shall be provided.

5.4.2.2 So far as is reasonably practicable, vertical service shafts shall not be surrounded by load bearing structural walls, to facilitate services installation and future alterations.

5.4.2.3 The Contractor shall be responsible for bunding and waterproof slab construction above theatres and in plant rooms to provide resilience and avoid flooding whilst ensuring functionality of engineering services.

5.4.3 **Manual Handling**

5.4.3.1 The Contractor, in the design of the Works, shall give due consideration to the obligations contained in the Manual Handling Regulations 1992 and ensure the appropriate allocation of space and structural capacity for the inclusion of mechanical devices, i.e. fixed and mobile hoists, robotic equipment and all FM, staff and patient lifts.

5.5 Sustainability

5.5.1 The Board has a significant asset base and, as a responsible healthcare provider and employer, it is committed to sustainability and carbon reduction in line with relevant and appropriate guidance and directives in this area. The Board has targeted an 'Excellent' BREEAM rating for the Project.

5.5.2 The specific sustainability considerations with regard to the Project and the requirements of the Contractor in this respect are detailed in Section 10.0 and Appendix M.

5.6 Control of Infection

5.6.1 Prevention and control of infection shall remain a primary consideration of the Contractor in the design and construction of the Works. The whole hospital design shall place a high priority on infection prevention and control in relation to the movement of goods and in particular the segregation as far as is reasonably practicable of clean linen, food trolleys and the removal of waste, soiled linen and empty food trolleys. The Contractor will be required to demonstrate to the satisfaction of the Board's Infection Control Team that the design and construction of the Works fully reflects and incorporates the following key infection control challenges;

a) Segregation of clean and dirty – laundry, food, healthcare waste;

b) Ventilation system – including the use of natural ventilation in relation to the affect by neighbourhood sources of environmental pollution;

c) Selection of Fixtures/fittings/flooring that are easy to clean and maintain;

d) Appropriate Isolation facilities;

e) Incorporation of appropriate workflows;

f) Handwash hygiene;

g) Wastewater and sewage/body fluid disposal;

h) Heating and lighting;

i) Water systems;

j) Food preparation.

5.6.2 The Contractor shall provide that all aspects of the Works allow the control and management of an outbreak and spread of infectious diseases in accordance with the following;

a. Infection Control in the Built Environment: Design and Planning (SHFN 30);

b. NHS Scotland HAI Scribe (Healthcare Associated Infection System for Controlling Risk In the Built Environment);

c. Scottish Infection Manual – 'Managing the Risk of HAI in NHS Scotland';

d. Guidance provided by Clinical Standards Board NHS QIS;

e. Textiles and Furniture (SHTM 87);

f. Ventilation in Healthcare Premises (SHTM 2025); and

g. The location of maintenance access to services and requirements of SHTM2023.

5.7 Design for Disability

5.7.1 The design shall comply with the requirements of the Disability Discrimination Act 1995, and take full consideration of HFN14 "Disability access", HFN20 "Access audits for primary healthcare facilities" and BS 8300:2001 “Design of buildings and their approaches to meet the needs of disabled people – code of practice”. Further guidance is provided in the NHS publication "Doubly Disabled: Equality for disabled people in the new NHS - Access to services”.

5.7.2 The Contractor shall ensure that the design and functionality of the Works meets the requirements of the Disability Discrimination Act 1995 as relevant and set standards of best practice to enable full access and use of the services and facilities available.

5.7.3 Entrances to the Works shall be clearly identified to promote ease of wayfinding and distinctive ‘landmarks’ shall be incorporated into the design particularly for the main entrances.

5.7.4 The Works’ environment, both externally and internally, shall be designed to be accessible to everyone. The journey onto the Site, from pedestrian / vehicle routes, through the main receptions, into the Works and to the desired locations shall follow a safe, logical and clear system.

5.7.5 Attention shall be paid in the design to all aspects of the physical environment relating to the accessibility of the Works as follows:

a. Access to buildings, such as level or ramped entry;

b. Emergency evacuation arrangements, in particular for the visually impaired, the disabled and the frail, such as fire refuges or alternative escape routes for people with mobility impairments;

c. The accessibility of external paths and landscaping;

d. Circulation within buildings, including their interior layout;

e. Effective lighting and signage and colour or tone contrast on doors to aid orientation;

f. Desks, laboratory benches, work surfaces and reception desks at varying or flexible heights;

g. Appropriate seating;

h. Accessible toilets; and

i. Convenient and reserved parking spaces for those who need them.

5.7.6 The Contractor shall ensure, as far as practically possible, that the Works design draws upon and endeavours to further develop improve and exceed current best practice and standards achieved in other similar projects, and incorporates full accessibility for the prospective patient groups, staff and public. This shall include aspects of both physical environment and visual and audio aids to enable full use of the Works for all groups. This philosophy of design shall be extended across all parts of the Works including access to the landscaped and external areas as well as the essential patient treatment and residential areas.

5.7.7 The Contractor shall ensure the design complies with the general accessibility ethos detailed above, whilst also addressing the detailed requirements listed elsewhere. It should be noted

that the requirements detailed are not exhaustive, and it is also recognised that specific clinical needs will determine the nature and design of Works in some areas.

In particular it is highlighted that the Works will be used by a high proportion of wheelchair users. The Contractor shall ensure that any fire evacuation procedures take full account of this.

In meeting the overarching obligations with respect to accessibility, The Contractor shall comply with the following non-exhaustive list of standards:

a. BS8300:2001 “Design of buildings and their approaches to meet the needs of disabled people – Code of practice”;

b. HFN 14 “Disability Access” and HFN20 “Access audits for primary healthcare Facilities”;

c. HFN 20 “Access audits for primary healthcare Facilities” ;and

d. HFN 21 “Car parking”.

5.7.8 BS8300:2001 is widely referred to by consultants advising on general building design in relation to the Disability Discrimination Act (1995). The Contractor shall therefore refer to this document and give full regard to its standards. It will, however be necessary to match the standards of BS8300 with others laid down in NHS guidance notes etc.

5.7.9 The Contractor shall also comply with further guidance contained in the NHS publication “Doubly Disabled: Equality for disabled people in the new NHS - Access to services”.

5.7.10 The obligations with respect to accessibility, as described in this Part 8 Section 3, are intended to reinforce the principles established within BS8300. Some, however, stand as requirements that deliberately exceed the minimum stated within BS8300. For the avoidance of doubt, specific accessibility requirements listed in this Part 8 Section 3 shall take precedence over the standards laid down in BS8300.

5.8 Equipment Requirements

5.8.1 The Equipment List is contained in Appendix F. This identifies equipment by Group (for pricing in bid returns), with location of equipment ascertained via the ADB Room Data Sheets (for all rooms) and exemplar 1:50s for those drawn at this stage. Group 1 Equipment shall be supplied and fitted by the Contractor, with Group 2 Equipment provided "free issue" to the Contractor by the Board and fitted by the Contractor. The Board are responsible for the supply and installation of Group 3 and Group 4 Equipment.

5.8.2 Notwithstanding the party who provides/supplies equipment, the Contractor shall identify and provide all necessary fixings and supports (to walls, ceilings and floors) connections and infrastructure (including supply, extraction and removal of waste) for all items of equipment listed in Appendix F.

5.8.3 The Contractor shall provide a suitable environment for each item of equipment as set out in the Room Data Sheets, this shall include accounting for temperature and ventilation requirements.

5.8.4 For the avoidance of doubt, this requirement specifically includes MEIGaN compliance and specialist service requirements by the Contractor, including for example 3-phase electrical supply, surge protection, standby power supply, ups, special water supply requirements and separation of contaminated waste.

5.8.5 For the avoidance of doubt, this requirement specifically includes the installation of renal water equipment and supplies by the Contractor to the meet the requirements of the Board.

5.8.6 Irrespective of the party responsible for the supply, installation, maintenance and replacement of each item of equipment, the Contractor shall provide Works that satisfy the following criteria:

a) allow Equipment and associated systems to be installed, commissioned, operated, maintained and replaced in accordance with:

   i) Good Industry Practice;

   ii) Manufacturer's instructions; and

   iii) The Board's, statutory health and safety requirements.

b) Allow Equipment and associated systems to operate efficiently, effectively and in accordance with its intended function for the whole of its design life when operated in accordance with the manufacturer's requirements;

c) Take due account of the impact on the environmental conditions within the Works;

d) Take due account of the potential impact of future equipment changes through either refresh or replacement. In particular, allowance for equipment of different sizes, weights, service requirements or environmental impacts;

e) Allow the Board to provide their Clinical and Non-Clinical Services with a minimum of disruption during installation, commissioning, operation, maintenance and replacement; and

f) Provide safe and unencumbered access for maintenance and replacement of equipment during the buildings life, to include pulley hoists, barrier walkways and

landings and reinforced routes and areas as necessary to assist the safe removal and replacement.

5.8.7 The construction, structure, plant and services shall be designed to meet the specific requirements for Special Equipment and associated services. The design of the Works shall meet these requirements with regards to mechanical and electrical servicing, wall and floor loads, structural movement and deflections, the need for special (including protected) floors, wall supports, ceiling grids and other such measures to allow for the installation, maintenance and replacement of Special Equipment and associated services. Specific Special Equipment is identified in Appendix F.2. The particular interface arrangements between the Contractor and the Board with regard to the provision and fit-out of Special Equipment shall be finalised during the Competitive Dialogue process.

5.8.8 The Contractor shall not change the Group designation of any Equipment. The Equipment List issued at Appendix F.1 shall be priced and submitted in the bid return with no additions, omissions or changes unless requested in writing by the Board as an aspect of the bid period.

5.8.9 The procurement, delivery and installation of Group 2 Equipment shall be as follows:

a) The Contractor shall procure and deliver, or arrange for the delivery to Site, all Group 2 Equipment to a secure central holding area (suitable for the equipment to be stored) to be provided by the Contractor. The holding area requires to be accessible by vans, 7t trucks and articulated vehicles – with vehicle movements in the operation of dropping off or picking up from the holding area to be managed by the Contractor;

b) The off loading or up loading of any Group 2 Equipment will be attended by the Contactor who shall acknowledge receipt of every delivery and sign the relevant delivery receipts to that effect. The Contractor shall manage and carry out the conveying of all Group 2 Equipment into the holding area;

c) The Contractor shall manage the movement and delivery of all Group 2 Equipment from the holding area to the point of installation in time for installation the same day;

d) The Contractor shall prepare and maintain a log of all Group 2 Equipment delivered to Site in an electronic and paper format, providing monthly updates to the Board of the status of delivered, stored and installed Group 2 Equipment; and

e) Should the Contractor arrange for a secure central holding area off or adjacent to the Site the Contractor remains responsible for the Group 2 Equipment that has been delivered and the movement of same to the Site for installation.

5.9 Materials

5.9.1 The Contractor shall ensure that all materials incorporated into the Works shall comply with the requirements of the Construction Products Regulations 1991, and all aspects of the Employer's Requirements.

5.9.2 The Contractor shall ensure that all products and materials to be incorporated into the Works shall be new unless otherwise agreed by the Board.

5.9.3 Where materials and components are not specifically identified as complying with the Construction Products Regulations 1991, The Contractor shall ensure that they comply with the relevant British Standards and Codes of Practice.

5.9.4 The Contractor shall ensure that the whole quantity of each product and material required to complete the Works is of a consistent type, quality and overall appearance and is fit for its intended purpose. The Contractor shall ensure all products and materials are handled, stored, prepared and used or fixed strictly in accordance with the manufacturers' written instructions or recommendations and not be damaged when incorporated into the Works.

5.9.5 The Contractor shall not construct the Works utilising substances which are hazardous to health, including but not limited to substances referred to as being hazardous to health and safety in "The Control of Substances Hazardous to Health Regulations 2002".

5.9.6 The Contractor shall not specify or include products or materials that do not comply with relevant British or European Standards, Codes of Practice or which are generally known within the European Union at the time of specification to be deleterious to health and safety or to the durability of buildings and / or other structures and / or finishes and / or equipment, plant and machinery in the particular circumstances in which they are used. Such materials include but are not limited to:

a) High alumina cement in structural elements;

b) Marine aggregates or their derivatives where the chloride iron content by mass of cement exceeds the requirements of Table 4 of BS 5328: Part 1;

c) Aggregates where the drying shrinkage characteristics, when tested in accordance with BS 812: Part 120, exceed a value of 0.05%;

d) Aggregates for use in reinforced concrete which do not comply with BS 882 or with the provisions of BS 8110;

e) Water used in construction or manufacture which is not clean, fresh or free from chemical or organic impurities or does not otherwise comply with BS 3148;

f) Concrete where the total mass of the reactive alkali in the concrete mix exceeds the recommendations set out in the Concrete Society Technical Report No 30;

g) Woodwool slabs in permanent formwork to concrete or in structural elements;

h) Calcium chloride in admixtures for use in reinforced concrete or reinforced masonry construction;

i) Calcium silicate bricks incorporated within any load-bearing part of the structures, or other areas of the construction which are deemed to be load-bearing in any way;

j) Asbestos or asbestos-containing products;

k) Lead, or any material containing lead, which may be ingested, inhaled or absorbed, except where copper alloy fittings containing lead are specifically required in drinking water pipework by any statutory requirement or in architectural design features (e.g. weather flashings, radiation protection);

l) Urea formaldehyde foam, or materials which may release formaldehyde in quantities which may be hazardous with reference to the limits set from time to time by the HSE, at the time of incorporation in to the Works comprising the project;

m) Softwood used externally, except for non structural landscaping or in areas agreed with the Board (e.g. pressure treated pine decking);

n) Slipbricks;

o) Polyisocyanurate foam;

p) Polyurethane foam;

q) Extruded polystyrene other than low ozone depletion materials;

r) Other substances, which at the time of their incorporation into the project, have been designated by the Building Research Establishment and published in their Digest, as deleterious to health and safety or deleterious to the building fabric, including both substructure and superstructure, in the particular circumstances in which these substances are used;

s) Products associated with the destruction or depletion of tropical rain forest or threatened animal species;

t) Products or manufacturing processes which cause the emission of pollutants, armful radiation or ozone depleting chemicals, as identified in the Montreal Protocol;

u) Use of noxious substances including DoE “Red List” and EC “List 1” substances;

v) Materials which are generally composed of mineral fibres, either man-made or naturally occurring, which have a diameter of 3 microns or less and a length of 200 microns or less, or which contain any fibres not sealed or otherwise stabilised to ensure that fibre migration is prevented;

w) Lightweight or air-entrained concrete bricks;

x) Iberian roof slates; and

y) Fibrous boards, including MDF board, in any external construction work.

5.9.7 The Contractor shall obtain confirmation that all timbers are “Certified Wood”.

5.9.8 The Contractor shall certify at Completion that none of the materials, products or constructions listed has been used in the construction of the Works, or incorporated in them, other than where specific written consent from the Board has been obtained. The Contractor shall also notify the Board of any other material which may become designated as prohibited at any time after incorporation into the project, during the Defects Period.

5.9.9 The Contractor shall provide samples and prepare mock-ups of external cladding systems or building components as requested by and for the approval of the Board as follows;

a) Sample panel of curtain walling/external wall construction, nom 4m x 4m to include a sample window and any associated bris soleil or sun shading detail. To remain as reference sample until envelope complete;

b) All external finishes;

c) External and internal doorsets;

d) External and Internal windows and curtain walling, including all standard ironmongery;

e) Ironmongery;

f) Typical bed head arrangement for Adult and Children's Wards (could be part of mock up);

g) Nurses Station design and materials – mock up;

h) Floor, wall and ceiling finishes – samples and colour schemes indicating interior design strategy intent;

i) Light fitments;

j) Power, voice and data switches outlets etc;

k) Sanitaryware, taps outlets and IPS proposals, (part of a mock up);

l) All signage and Wayfinding proposals;

m) Lifts and other key M&E installations;

n) Wall protection and handrail systems;

o) Public art; and

p) Hard and soft landscape proposals and external works.

5.10 Energy Strategy

5.10.1 In accordance with best practice, the Contractor shall consider key design features including, but not limited to:

a) Use of passive ventilation where appropriate whilst minimizing mechanical cooling;

b) Use of heat recovery for exhaust air;

c) Use of redesigning processes and products to close the technical loop using recovered and bio-based materials;

d) Use of natural daylight into areas which require continuous illumination such as central/circulation areas;
e) Use of natural daylight through maximum use of lighting dimmer controls; and

f) Implementation of renewable energy sources – solar, wind, landfill gas, biomass and low impact hydroelectric, geothermal, low carbon heating systems and heat pumps.

5.10.2 The Contractor shall demonstrate that their proposals will effectively reduce water consumption below the average consumption data contained in SHTM 2027 for the type of accommodation being developed by the Board. The Contractor's proposals shall include estimated consumption for the Works in Litres/Bed/Day and measures that they propose allowing the Board to minimise consumption.

5.10.3 In the consideration of design for energy generation and use Bidders are requested to be aware of and consider possibilities around alignment with the "Sustainable Glasgow" initiative. The Bidders are to demonstrate such consideration and report on their findings. The contact point for Sustainable Glasgow is:

Richard Bellingham
Senior Research Fellow
Energy Policy
Fraser of Allander Institute
University of Strathclyde
richard.bellingham[redacted]

5.10.4 The Contractor shall submit a Mandatory Variant bid providing for a Maximum Temperature provision (26degC).

5.10.5 The specific energy requirements of the Board are detailed in Section 8.0 and Appendix M.

5.11 Fire Strategy

5.11.1 Fire safety in the proposed facility shall be controlled by Building Regulation, Health Technical Memoranda Firecode, and Fire Practice Notes, subject to approval by the Board's Fire Safety Advisor.

5.11.2 The Contractor must comply with the requirements of these publications, as a minimum standard, although it is recognised that alternative solutions based on a fire engineering approach may be more appropriate to the Contractor's design. Should the Contractor pursue an alternative approach it shall be their responsibility for meeting the minimum standards set out in the publications, fully satisfying the regulatory authorities of the appropriateness of its proposals and obtaining the necessary approvals.

5.11.3 The Contractor is required to prepare a Fire Safety Strategy document, including Fire Strategy drawings to demonstrate compliance with the relevant regulations. This document shall cover all aspects of fire safety, fire fighting and building management, including compartmentation and the ventilation implications of the Building.

5.11.4 The Contractor shall be required to ensure that all premises to be occupied by the Board have been appraised prior to occupation by competent persons appointed by the Board for compliance with Firecode and all Legislation are being met and shall provide the Board with an Annual Certificate of Firecode Compliance. For the avoidance of doubt the Contractor shall provide all fixed and portable fire fighting equipment to comply with statutory requirements and those of NHS Scotland Firecode. For the avoidance of doubt the Contractor requires to accommodate all fire fighting equipment which will be located within secure lockable containers housed in the wall construction, and operated by the same key throughout the development.

5.11.5 The Contractor shall provide a fully operational fire alarm system to meet the needs of the Works.

5.11.6 The specific requirements of the Board with regard to Fire Strategy are detailed in Appendix R.

5.12 Flexibility and Adaptability

5.12.1 The Contractor shall in the design of the Works consider opportunities which present themselves for the future expansion of Clinical and Non-Clinical Services.

5.12.2 The Contractor shall ensure, as far as is practical, that the Works structure and envelope, services, partitioning, ceiling, and flooring systems are consistent with a co-ordinated methodology which facilitates future flexibility for re-planning and change in the layout of departments, rooms, services outlets and equipment. In particular, it shall be possible to install or relocate fittings, fixtures, equipment and service outlets with minimum disruption to the use of the Works.

5.12.3 The design for the Works shall take full account of, but not be limited to:

a) Changes in technology, both clinical and non-clinical (e.g. systems of care and volume of work);

b) Building structures shall be designed by the Contractor to facilitate ease of alteration to the internal layout of the building, or to its plant, services or equipment, during the lifetime of the buildings. This shall be achieved by;

i. Selecting structural forms in which future builderworks holes for building services distribution, both vertically and horizontally (including ductwork), or equipment, may be cut simply and economically, minimising the installation of secondary framing;

ii. Providing knock out panels to permit the formation of holes not exceeding 150x150mm through suspended floors, adjacent to 50% of the internal columns on all floors. These knock out panels shall be positioned close to columns distributed across all areas of each floor;

iii. Designing the floors for imposed loadings that will permit the reallocation of space within the Works, so that each area of floor is structurally capable of supporting the imposed loads of offices, wards, corridors, general storage areas or waiting areas, together with their appropriate partition walls, finishes, ceilings, services and medical Equipment;

iv. Providing removable access panels within the structure, where these are required for the installation or removal of plant, services or equipment;

v. Internal room walls to be constructed such that they can be readily removed or altered i.e. the structure is not reliant on the walls for structural stability;

vi. Designing the structure of the buildings so that any future extensions can be constructed and brought into service with minimum disruption to the operation of the Works; and

vii. Designing plant space and riser space so that a future 25% services capacity expansion can be accommodated.

5.12.4 The structure and foundations of the buildings shall be designed by the Contractor to permit the construction in the future of further accommodation by extending the buildings horizontally or constructing further new buildings adjacent to them.

5.13 Facilities Management

5.13.1 The SoA and exemplar design have taken cognisance of the operational requirements and space/location requirements of the Board. The Contractor requires to comply with as well as design the Works to support and comply with the Board Policies (contained in Appendix P).

5.13.2 The specific requirements with regard to automatic material handling equipment (robotics), and the development of the Board's requirements and design in that regard, will be addressed during the competitive dialogue process. Details with regard to automatic material handling equipment is contained in Appendix M.

5.13.3 The Board shall have personnel integrated into the project development and the Works operations in relation to familiarisation and FM operations. The Contractor shall at all times liaise and support the integration and requirements of the Board in this respect at no additional cost.

5.13.4 The Contractor is required to provide space for maintainable, replaceable building services and plant.

5.13.5 The Contractor shall ensure that plant and equipment is suitably identified in line with the NHSScotland asset management system or equal and approved system/technologies.

5.14 Design Development

5.14.1 The bid period has specific bid return requirements (detailed in Volume 3 of the ITPD) with regard to written and drawn design information. Once the Contractor is appointed, the period to Full Business Case (FBC) approval comprises design development of the Contractor's Proposals in relation to the Hospitals, concurrent with the design and construction of the Laboratories. The design development to FBC will be fully programmed and demonstrable in a priced Activity Schedule forming an aspect of the bid returns from bidders.

5.14.2 The procedure for the review of design development will be agreed with the Contractor prior to the return of bids and the commencement of the design development.

5.14.3 The Contractor shall, as a minimum requirement, provide the information detailed in Appendix K (Design Development) as an output of Stage 2 (Hospitals Detailed Design to FBC). The satisfactory production of completed Appendix K information to the Board is one of the pre-conditions to the approval to proceed to Stage 3. More information relating to Stages 2, 3 and 3A are contained in Volume 1 of the ITPD.

5.15 Extended Defects Period

5.15.1 Due to a number of factors, including double-running/transition from other hospital sites, the Board are desirous of a defects period that provides management and physical benefits to the Project. In this regard a period in excess of the 'traditional' one year defects will be sought, with particular associated requirements in relation to:

a) Training and handover to Board personnel;

b) Correction times/periods for defects;

c) Seasonal commissioning;

d) Management activities; and

e) Performance requirements.

5.15.2 Volume 1 of the ITPD details further particular Extended Defects Period (EDP) requirements of the Board and identifies that this will form an aspect of Competitive Dialogue with bidders under the Commercial workstream.

5.16 Critical Failures

5.16.1 The Board require that the Works have inherent aspects of resilience to critical failures and mitigate operational interruptions.

5.16.2 In this regard, the Board have identified particular considerations and requirements that the Contractor shall adopt and develop as an aspect of bid return and design development. In addition to the resilience requirements of NHS Publications and the design requirements stated elsewhere in the Employer's Requirements, specific areas that the Board have prepared as exemplary are identified in Appendix X (Critical Failures).

5.16.3 The Contractor is required to comply with the provisions of Appendix X in their design, as well as provide for a developed strategy in relation to mitigation of critical failures in their bid return.

Section 6.0 Construction Phase Requirements

6.1 Site Logistics, Welfare and Board Accommodation

6.1.1 The Contractor is responsible for the provision of all temporary site accommodation/welfare and associated requirements, including the provision of car parking for site operatives during the design and construction stages. All such accommodation requires to be metered to provide readings of all utilities usage separately at any time.

6.1.2 No Contractor staff or personnel (including any sub-contractors, suppliers, supply chain members or other personnel providing any goods or services to the Contractor) are allowed to park on the Hospital Campus (except where attending as a patient or visiting/assisting a patient) during the Works.

6.1.3 The Board require the Contractor to provide dedicated site accommodation for the exclusive use of the Board and its representatives. This requires to be in the immediate environs of the Contractor accommodation on/adjacent to the Site to support joint working and meetings, but must facilitate segregation such that the Board area has a dedicated access for their use.

6.1.4 The Board require dedicated fully serviced accommodation including:

a) an open plan area with workstations, sockets and IT + telecoms connections for 10 persons;

b) an open plan area with workstations, sockets and IT + telecoms connections for 20 persons;

c) cellular offices with workstations, sockets and IT + telecoms connections for 5 persons;

d) a meeting room to accommodate 15 persons, serviced with sockets and IT + telecoms connections;

e) a suitably serviced room to accommodate a 1GB router;

f) secure wireless connectivity;

g) male, female and disabled toilet facilities;

h) a kitchen area with seating for 10 persons; and

i) adjacent dedicated parking for 30 cars.

6.1.5 The Contractor accommodation adjacent but separate from the Board accommodation will provide shared meeting rooms for 30, 20 and 10 persons separately as a minimum requirement.

6.1.6 The provision of site welfare and accommodation will form an aspect of Competitive Dialogue with the Board under the Logistics workstream. This workstream will also consider other logistics issues such as deliveries to site, site traffic and storage provision. The specific logistics, requirements, constraints and parameters of these aspects of the Project will be discussed and considered in detail to allow the generation of relevant information and potential solutions by bidders for the Board to consider and discuss. This will include proposals for the location of welfare, storage and parking solutions as well as layouts for site accommodation and welfare.

6.1.7 Further, specific requirements of the Planners to be met by the Contractor are identified in the Outline Planning document in Appendix D.1.

6.1.8 The Contractor shall be responsible for the cost provision and maintenance of all site signs and hoardings during the construction phase of the works. The requirements of NHS Scotland signage guidelines will require to be met by the Contractor, for the avoidance of doubt the key requirements are as follows;

a) Principal signage required at 3 no.key locations around the site as NHS Scotland signage guidelines;

b) Principal signage size will be no less that 6 x 4 metres;

c) NHS Greater Glasgow and Clyde identity prominently displayed (no less that 350mm in height) on hoardings enclosing entirety of site;

d) Graphics should be made from vinyl or other suitably durable material; and

e) All hoardings must be 2400mm high solid panels (metal or timber) with viewing panels painted white and maintained in good condition, free from graffiti and posters at all times.

6.1.9 All signage to include space for signage boards provided by the Board project manager for display and use – particular numbers and sizing of boards in this regard to be clarified to bidders by the Board.

6.2 Site Preparation Works

6.2.1 The Contractor shall be responsible for identifying and undertaking all preparation works necessary in order to make the Site suitable for the development of the Works. These works shall be undertaken prior to commencement of, or integrated with, the Stage 1 and Stage 3 activities.

6.2.2 For the avoidance of doubt, this obligation covers but is not necessarily limited to:

a) The identification of all protected trees to be removed from the Site by virtue of their condition and / or position in relation to the proposed Works. The Contractor shall be responsible for seeking the approval of Glasgow City Council for any such removal proposals, and the proposed mitigation / replacement strategy, in accordance with the conditions of Glasgow City Council's requirements and the associated Local Plan;

b) The identification and implementation of protective measures required to remaining trees, including their root systems, in accordance with BS 5837:2005, "Guide for trees in relation to construction";

c) In accordance with the Wildlife & Countryside Act 1981, any tree felling and shrub clearance shall be carried out outside the bird breeding season (March to August). Contractors shall take due cognisance of this requirement in any work programming. Where this is not possible a qualified ecologist shall be appointed to examine all potential breeding sites before any clearance takes place. If occupied nests are found, clearance and felling works shall cease until the nest is no longer in use. The contractor shall formally confirm to the Planning Authority in writing if clearance is in order following the ecologist's inspection;

d) Japanese Knotweed (JK) - Areas of the site have been the subject of contamination by Japanese Knotweed. The Board have embarked on a programme of eradication, details of which will be made available to the Contractor. The Contractor shall be

required to dig up any JK plant material and transport to a separately identified bunded area on the site (to be formed by the Contractor) where the JK shall be treated by the Board. The Contractor shall provide wheel washing provision for the vehicles utilised in the transportation and removal of JK (including Board vehicles involved in ultimate removal from the site);

e) The identification, decommissioning, removal and / or protection / relocation of live (and used), live (and redundant) or redundant (and disconnected) buried services crossing the Site;

f) The identification and removal of old foundations, drainage runs, basement structures and other below ground obstructions present following demolition of previous structures occupying the Site that are not removed by the Board (e.g. some steam duct lines);

g) Upon the finding of any medical waste or other contaminants on the site the Contractor shall advise the Board of such discovery for discussion and agreement of the necessary removal and/or protection steps to be taken; and

h) Diversion of the culverts.

6.2.3 Where relevant, the Contractor shall carry out all site preparation works (if necessary) in accordance with BS 6187:2000 “Code of Practice for Demolition” and the following:

a) Issue a method statement identifying the scope and methodology for undertaking the enabling works (if any), for approval by the Board in accordance with (TBC);

b) Break up and remove offsite all foundations, temporary accommodation, and other below ground and surface obstructions in accordance with, but not limited to, BS5528 “Demolition in open spaces”;

c) Decommission and / or break up and remove all redundant underground structures, chambers and redundant surface water and foul water drains, telecommunications, electric cables, gas mains, water mains and ducts within the Site. For the avoidance of doubt, this obligations includes for making safe all redundant works left in-situ, and sealing of voids, where left, against vermin;

d) Protect remaining services against damage or disruption; and

e) Minimise vibration and noise produced by the demolition works, and agree appropriate limits for such with the Board and neighbours.

6.3 Workmanship, Construction Accuracy & Tolerances

6.3.1 The Contractor shall ensure that general workmanship conforms to current revisions of BS 8000: – “Workmanship on Building Sites”, which covers typical building construction activities. Where specialist design proposals require construction activities outside the scope of this document, The Contractor shall propose specific quality procedures relating to these activities based on Good Industry Practice current at the time, as a minimum.

6.3.2 The buildings and the external works shall be designed and set out by The Contractor in accordance with BS 5606:1990 “Guide to Accuracy in Building”.

6.3.3 In some situations the tolerances identified in BS 5606 may not be appropriate for the particular elements or combination of elements in the Works. Where special levels of accuracy are required in relation to The Contractor’s proposals these shall be stated by The Contractor. The Contractor shall consider the recommended procedure set out in Figure 8, Section 4, Appendix B, of BS 5606.

6.3.4 The Contractor shall identify critical dimensions and setting out points on all its drawn information.

6.3.5 The Schedule of Accommodation contained in Appendix C of the Employers Requirements details the number and net floor area (as defined in paragraph 2 below) of the all relevant rooms or spaces in the Works, and the Gross Floor Area (as defined in paragraph 2 below) of the departments within The Works.

6.3.6 The actual floor area (as constructed) of a room or space may vary by up to 2% less or greater than the net floor area of the relevant room or space recorded on the Schedule of Accommodation (which actual floor area shall be measured on the same basis as that referred to in the definition of net floor area in paragraph 2 below) always provided that the proportion of the room remains generally unchanged. However the Contractor should note that the Single Bedrooms (as constructed) are required as a minimum to comply with the Schedule of Accommodation space requirements.

6.3.7 The net floor areas of rooms and spaces/departments and the other areas shown in the Schedule of Accommodation shall only be amended insofar as an Approved Project Managers Change Instruction varies such areas.

6.3.8 The Contractor will remain entirely responsible for procuring that the net floor areas of rooms and spaces/departments as shown in the Schedule of Accommodation applicable to the Works are capable of being achieved within the total gross floor area of the Works specified in such Schedule of Accommodation. The overall as built net floor area of the Works shall be not less than the total net floor area shown in the Schedule of Accommodation by more than1%.

6.3.9 The net floor areas of the individual rooms and spaces listed in this Schedules of Accommodation shall be calculated using a manually operated electronic measurement computer programme from a Computer Aided Design (CAD) system.

6.3.10 The number and identification of rooms listed on a department by department basis in the Schedule of Accommodation are as noted and identified on the 1:200 Departmental Layout plans identified in Appendix I.

6.3.11 For the duration of the Works the Contractor shall;

a) maintain computerised electronic versions of the Schedule of Accommodation and shall regularly update the areas shown in the Schedule of Accommodation from time to time in order to, inter alia, properly record the net floor areas and gross floor areas stated in all items of Design Development;

b) Afford the Board's Representative and Project Manager an opportunity to access and view such computerised Schedule of Accommodation at any time during normal working hours; and

c) As soon as reasonably practicable following finalisation of the 1:50 scale Room Layout Drawings, shall prepare and issue to the Board (in hard copy and electronic format) the final Schedule of Accommodation for the Works.

6.3.12 In connection with the above the following definitions apply;

a) Net floor area

In relation to a room the area bounded by the internal face of the walls or partitions enclosing the room. Or in relation to the space the area bounded by the internal face of

the walls or partitions and boundary(s) to any adjoining space(s). This area shall be measured elctronically from the approved plans that relate to the room or space. The net floor area is measured with deductions for:

i) column encasures

ii) pipe boxing

iii) service zones

b) for the avoidance of doubt the actual floor area may not be the net floor area of the room or space. The net floor area shall include the area of furniture, fittings and equipment within the room or space;

c) The net floor area for the department will be the sum of the individual net floor areas for the relevant rooms;

d) Gross floor area

Gross Departmental Area means the area bounded by the internal face of the external walls, centre line of partitions or boundary to adjoining departmental and/or communication space(s) that enclose that department. This area shall be measured electronically from the 1:200 scale Department Layout Plan that relates to the department. The Gross floor area shall include all elements of construction, spaces or rooms and circulation, but exclude:

i. service ducts

ii. lift shafts or other communication spaces contained within the boundary of the department.

e) Other areas means all other areas not included in a department, the balance of all service ducts, lift shafts, communication spaces (not included in department areas), corridors, plant rooms and the like measured electronically on the same basis as a Department from the 1:200 scale Department Layouts. The department areas are identified in Appendix I;

f) In relation to the Works, the Gross floor area is the sum of items d) and e) above; and

g) The departmental areas are identified in Appendix C.

6.3.13 Control of Noise & Dust

6.3.13.1 The attention of The Contractor is drawn to the provisions of Section 60 of the Control of Pollution Act 1974, with reference to the control of noise and dust in relation to any construction works. Where such works are adjacent to occupied property, The Contractor shall ascertain from the relevant authorities what requirements or restrictions, if any, shall apply, particularly in relation to Aspergillus. The restrictions may relate to the type of plant to be used, siting of plant, methods of working to be adopted, the hours of work permissible and may, in addition, impose a maximum noise level that must not be exceeded.

6.3.13.2 The Contractor shall make applications as early as possible to the utility company for the relevant connections in order to avoid the use of site generators.

6.3.14 The Contractor shall fit compressors, percussion tools and vehicles with effective silencers of a type recommended by the manufactures of the compressors, tools or vehicles but in any event to the requirements of BS 5228: Part 1: 1997 in accordance with Good Industry Practice.

6.3.15 Any equipment of a semi-permanent nature used by the Contractor, which produces noise on a regular basis, shall be positioned to cause the minimum disturbance to adjacent areas in agreement with the relevant authorities. The Contractor shall take all reasonable measures throughout the course of the Works to prevent the egress of water, dust, debris or any microbiological contamination out of the Site and into adjacent buildings. In particular, the Contractor shall establish any specific requirements for the control of dust identified.

6.3.16 The Contractor must comply with the specific planning requirements with regard to the control of noise and dust.

6.3.17 Continuity of Existing Services

6.3.18 The Contractor shall plan and execute the Works to ensure the Works activities do not affect the operational continuity of the Hospital Campus and the immediate neighbours to the Site.

6.3.19 The Contractor shall ensure that all reasonable safeguards are incorporated to ensure continuity of utility supplies to the Hospital Campus and adjacent users of the Site in-so-far as they may be affected by the Works. For the avoidance of doubt, utility supplies include, but are not limited to, gas, medical gases and air, electricity, water, sewerage and communications services.

6.4 Live Hospital Site

6.4.1 The Hospital Campus is a live hospital site, and as such will place restrictions on the Contractor in the construction of the Works.

6.4.2 As is noted in Section 6.1, above, logistics of the Site will form a workstream under the Competitive Dialogue to take place between the Board and the Contractor and this will extend to the consideration, discussion and agreement in regard to particular constraints, routes, timings and the like that will and will not be possible in the carrying out of the Works due to the 'live' nature of the environment.

6.4.3 Specific site constraints and access type requirements of the Hospital Campus and the Site have been considered in advance by the Board. These are contained in Appendix A and identify, amongst other issues, 'blue light' routes, FM delivery points and roadways that require to be unobstructed by the Contractor 24hours per day, every day.

6.4.4 The use of tower cranes on site by the Contractor may be restricted by the Board, Planners and the CAA. The Contractor is required to establish any relevant constraints and shall be responsible for implementation of craneage as permitted. This will include no oversailing of areas out with the Site and shall require the Contractor to demonstrate his management proposals in this regard, including modelling of swing-arcs and the like. Specific CAA requirement for aircraft warning lights are to be installed by the Contractor with regard to temporary and permanent structures. This will extend to, but may not be limited to, tower cranes, the flue to the new energy centre, other flues and chimneys to the Works;

6.4.5 In addition to the physical logistics and constraints in respect of the live hospital environment, the Contractor shall require to observe and comply fully with specific Board Policies for the duration of the Works when on the Hospital Campus or Site. The relevant Board Policies are listed in Appendix P.

6.4.6 The Contractor will require to carry out dilapidation surveys prior to the commencement of the Works, during the Works and at the completion of the Works – the extent, format and location of such to be agreed with the Board. Hard and electronic copies of all dilapidation surveys to be provided to the Board by the Contractor.

6.4.7 An aspect of the surveys to be carried out by the Contractor prior to the commencement of the Works is a full photographic survey of the boundary of the site, adjacent buildings, main roadways and approach roadways. Hard and electronic copies of all photo surveys to be provided to the Board by the Contractor.

6.5 Standardisation and Prefabrication (incl modular and off-site)

6.5.1 In order to take advantage of the repetitive nature of construction, maximise productivity and efficiency and minimise construction periods and waste, consideration shall be given to off-site prefabrication. It shall specifically be applied to repetitive elements e.g., sanitary assemblies, bathrooms or complex equipment such as plant assemblies.

6.5.2 The Contractor shall where reasonably practicable use standardised and / or pre-fabricated components and elements of construction which improve product quality, guarantee consistency of performance, optimise maintenance, and provide for reasonable flexibility for future changes, ease of replacement and value for money.

6.5.3 The use of standardised / prefabricated elements and building components to achieve good quality control, ease and speed of installation and flexibility for future use are welcomed. Their use shall not constrict the Board achieving clinical functionality and offer value for money. Items which may be considered include, bathroom pods, bedroom pods and other repetitive elements.

6.6 Room Mock-ups

6.6.1 The Contractor shall construct exemplar room mock-ups during the design development stage of the Works (Stage 2) for the hospitals. This will allow the Board's Representative to witness the quality standards of workmanship according to Good Industry Practice. Exemplar typical room mock-ups will be constructed for the rooms listed below in order to demonstrate important or unusual design elements of rooms i.e. integral bespoke furniture.

6.6.2 The Contractor shall provide mock-ups of the following rooms for use in the design development and approval process:

a) Single bedroom (standard) with en-suite (adult hospital);

b) Single bedroom with pull down bed for parents (children's hospital);

c) Single bed space (Critical Care) including all services and screening; and

d) Any modular accommodation proposed by the Contractor.

6.6.3 During the construction phase of the Works (Stage 3), the Contractor shall prepare a number of exemplar rooms as part of the Quality Control process, this is in addition to or a development of the mock ups noted above. The Contractor shall provide exemplar rooms of the following rooms:

a) Generic treatment room;

b) Single bedroom (standard) with en-suite;

c) Standard Outpatient Consulting Room;

d) Theatre suite;

e) Renal dialysis station and example of renal media panel;

f) Staff base; and

g) Reception point/counter.

6.6.4 These will establish minimum quality standards for the main areas and shall include main building services elements including lighting, heating, staff call, fire alarms, patient entertainment systems and all power and data accessories. This shall, where appropriate, include 3D computer illustrations.

6.6.5 The exemplar rooms to be prepared in the construction phase of the Works (Stage 3) shall portray doors, windows and the principal fitments and furniture. They shall allow definition of floors and walls, reflect the ceiling arrangements and identify the engineering services terminals. These shall be provided in a timely manner, to ensure they add value to the design development and approval process. The Contractor shall agree the content of and construct the exemplar mock-up rooms to a timetable to be agreed with the Board.

6.7 Witnessing and Testing

6.7.1 Witnessing and testing duties will be carried out by the Supervisor, all as detailed in relevant Clauses of the current NEC3 Engineering and Construction Contract, namely;

TITLE	DESCRIPTION	CLAUSE REFERENCE(S)	SUPERVISOR and CONTRACTOR DUTIES
Section 1	General	10.1; 11.2(6); 13.1; 13.3; 13.6; 14.1; 14.2; 14.4	10.1 – to act as stated in the contract and in a spirit of mutual trust and co-operation. 13.1 – to communicate in a form which can be read, copied and recorded. 13.3 – to reply to a communication within the period for reply 13.6 – to issue certificates to the Project Manager and Contractor 14.1 – Contractors duty to provide the works and be responsible for design. 14.2 – to notify the Contractor before delegating any actions or cancelling any delegation. 14.4 – replacement of Supervisor.
Section 2	Contractors Main Responsibilities	27.2; 27.3	Contractor's duties in relation to site access/action on legitimate instructions
Section 3	Time	n.a.	
Section 4	Testing and Defects	40.3; 40.5; 41.1; 42.1; 42.2; 43.1; 43.3	40.3 – to notify the Contractor of his tests and inspections before they start and afterwards of the results. 40,5 – to do tests and inspections without causing unnecessary delay to work or payment. 41.1 – to notify the Contractor of the results of the test or inspection on Plant and Materials required by the Works Information to be tested or inspected before delivery. 42.1 – instruct the Contractor to search for a Defect and to give reasons for searches which are instructed. 42.2 – to notify the Contractor of defects found before the Defects Date. 43.1 Contractor duty to correct Defects whether notified by Supervisor or not.

			43.3 – to issue the Defects Certificate at the later of the Defects Date and the last Defect Correction Period.
TITLE	**DESCRIPTION**	**CLAUSE REFERENCE(S)**	**SUPERVISOR and CONTRACTOR DUTIES**
Section 5	Payments	50.1	Project Manager duty in relation to assessing amounts due.
Section 6	Compensation Events	60.1(6)(8)(10)(11); 61.1	Actions/inactions of Supervisor in connection with Compensation Events.
Section 7	Title	70.1; 71.1	70.1 – Supervisor signing for marked Plant and Materials outside Works Area. 71.1 – Contractor action to allow Supervisor signing for marked Plant and Materials outside Works Area.
	Dispute Resolution	W1.3(5); W2.3(4)	Actions/inactions of Supervisor in connection with dispute Resolution Procedure.

6.7.2 It is envisaged that the Supervisor role will be carried out by a number of delegated parties – parties will be delegated by named Supervisor all as Clause 14.2, and are likely to comprise the following;

a) Civil & Structural Engineering;

b) Mechanical & Electrical Services;

c) Board Personnel (FM Services); and

d) Civil/M&E/Fabric Clerks of Works

6.7.3 In relation to the above duties as detailed under Section 4 – Testing and Defects, the Supervisor will carry out the following functions;

a) Design Compliance Check

i) Review the Design Data and detailed design information for general compliance with the terms of the Contract;

b) Procedure Review

i) review the quality assurance procedures proposed by the Contractor before work begins on the Laboratory and Hospital sites and review the operation of the procedures at regular intervals during The Works;

ii) regularly check to see whether the procedures employed by the Contractor are generally in accordance with the terms of the Contract; and

iii) review the proposed procedures and programmes for testing, commissioning and hand-over of The Works.

c) Construction Review

To the extent necessary to carry out the services referred to in Section 4 of the NEC3 Contract:-

i) enter the Laboratory and Hospital sites to monitor The Works to view the general state and progress of the Works to review overall workmanship, samples of goods and materials used or about to be used in The Works and to ascertain generally that the terms of the Contract have been and are being complied with by the Contractor;

ii) the frequency and timing of the Supervisor's visits are dependent on the progress of construction on the Laboratory and Hospital sites;

iii) regularly check to see whether the Contractor's work is being undertaken in accordance with Method Statements, Works Information and in a workmanlike manner;

iv) witness the testing, review and consider the suitability of all M & E and Building Management Systems, test results and certificates and other procedures within the Contractor's commissioning activities (all test results and certificates and other relevant commissioning and snagging paperwork to be collated by Independent Commissioning Engineer and provided to the Supervisor). In the event that a test carried out by the Contractor does not satisfy the terms of the Contract, check to see whether suitable remedial actions have been implemented and satisfactory results have been obtained on any re-tests;

v) generally inspect rectification works which have previously prevented the Supervisor from issuing a Defects Certificate; and

vi) undertake a visual inspection as appropriate of The Works before hand-over, to see whether the appearance is generally acceptable and in accordance with the terms of the Contract.

d) Reports

i) Report on the status of The Works following each site visit (and at any other time as appropriate) identifying any work that is non-compliant with the Contract; and

ii) Produce a weekly report following each site visit to ensure that the Employer is kept fully and properly informed on all aspects of the Works.

e) Familiarisation with Other Project Documents

i) The Supervisor shall familiarise itself with the Design Data and the Project Documents to the extent necessary to carry out the Supervisor role as provided for in accordance with the terms of the Contract;

f) Familiarisation with Quality Manuals

i) The Supervisor shall familiarise itself with and understand the Quality Manuals for the design and construction of the Project as set out in the Contract;

g) Monitoring and Inspection Procedure

i) The Supervisor and the Contractor shall agree an ongoing monitoring and inspection procedure, with reference to the Contract's key construction and

commissioning activities and the completed Works, and shall operate the same so as to ensure the efficient monitoring of construction and the efficient operation of activities;

h) Certification

i) The Contractor shall give the Supervisor (and Project Manager) sufficient notice in accordance with the Contract, of the date (the Completion Date") when it anticipates that Completion in respect of any Project Phase will be achieved;

ii) The Supervisor shall issue the relevant Defects Completion Certificate(s) in accordance with Clause 43.3 of the Contract; and

iii) As soon as practicable following the issue by the Project Manager of the Completion Certificate in respect of the final Project Phase to be completed in accordance with the Construction Programme, the Supervisor shall (provided that the Contractor has complied with its obligations to remedy any works listed in the Defects List) issue a final Defects Certificate.;

i) Snagging Items

i) The Contractor shall produce a Snagging Protocol detailing the process and individual party inputs, to cover the Phases of the Works. It is expected that this Protocol will be developed in conjunction with all interested parties e.g.:

- Board Representatives/Users/FM Team
- Supervisor
- Independent Commissioning Engineer
- The Contractor

and be provided at least six months prior to Phase Completion Date(s);

ii) The Contractor will provide for a computer/software based integrated snagging management system to be utilised during the snagging process, Provision to include all necessary peripheral equipment (PDA/Pens) and include for necessary training for Board Users and their advisors;

iii) The system will be managed and maintained by the Contractor, with appropriate access granted to project personnel; and

iv) Under the NEC3 Contract, there will be a "zero defects" approach to the project, and the Snagging Protocol will reflect this approach;

j) Notification of Completion of Defects

i) The Supervisor shall when requested by The Contractor attend any meetings convened about any part of the Works for the purpose of inspecting whether the Defects items applicable thereto have been remedied and/ or rectified; and

ii) The Supervisor shall issue a Defects Certificate, with copies of such notification also being issued, once all the works and other activities required in order to remedy and/or rectify Defects have been completed to the standards required by the Contract;

k) Miscellaneous

The Supervisor shall:

i) monitor the progress of the Contractor's design production;

ii) observe and monitor mock-ups, fabrication, construction and installation works on the Sites so as to satisfy itself that the Works comply with the Contract;

iii) audit the Contractor's Quality Assurance and the Contract control systems and procedures;

iv) issue Defect/Non-compliance notices and oversee the resolution of non-compliant matters;

v) review the commissioning of components of the Works in accordance with Contract/Works Information (as appropriate). The Supervisor will audit and monitor the commissioning work and report on the commissioning and testing of the Works;

vi) inspect and sign for marked up Plant & Materials outside of Works Area in accordance with Clauses 41.1/70.1/71.1; and

vii) hold regular meetings to discuss compliance and progress matters with the Employer and his Technical Advisors and the Contractor and attend meetings between the Employer and the Contractor as appropriate.

6.7.4 In order to assist the Supervisor in the performance of the above duties, the Contractor shall, as a minimum provide the following information;

a) the Accepted Programme;

b) copies of the Contractor's working programmes showing when the Contractor intends to carry out key activities whether off or on Site;

c) copies of all relevant documentation in connection with Plant & Materials outside of Works Area;

d) copies of such working drawings, schedules and specifications prepared for tender issue to the Contractor's sub-contractors as may reasonably be required by the Supervisor;

e) access to designs, drawings and documents register, technical and audit reports, consents, certificates and specifications to a level necessary to allow the Supervisor to assess compliance;

f) copies of correspondence relating to Building Control matters;

g) access to all quality control and quality assurance records, including procedures and method statements for the Project;

h) copies of all non-compliance reports generated by the Contractor and evidence of the clearance of the same;

i) copies of commissioning reports;

j) access to draft and final building/O&M manuals at the same time as the same are required to be provided to The Contractor under the Contract and otherwise as may reasonably be required by the Supervisor;

k) a copy of the health and safety plan and health and safety file and access to safety reports;

l) The Contractor's progress reports;

m) Any available completion check-lists prepared by the Contractor;

n) Change orders/requests prepared by the Contractor relating to the Works;

o) Copies of any reference or notice of intention to refer a dispute to the dispute resolution procedure in relation to the Works; and

p) The Defects List.

6.8 Commissioning and Handover

6.8.1 It is envisaged that the Contractor will appoint an Independent Commissioning Engineer to manage/programme/collate all M&E Testing and Commissioning processes, all as detailed in Appendix M, M&E3 Section 5 of the Employers Requirements

6.8.2 The Contractor will be required to provide the following in relation to the Commissioning and Handover process.

a) Final Commissioning Programme

i) A Final Commissioning Programme shall be prepared for each Phase to replace the Outline Commissioning Programme. The Final Commissioning Programme relating to the relevant Phase shall be prepared in consultation with the Board, in accordance with the requirement of the Completion Process;

b) Pre-Completion Commissioning

i) The Contractor's Pre-Completion Commissioning shall comprise the activities described as such in Table A Commissioning – Outline Commissioning Programme;

ii) The Contractor shall give written notice to the Project Manager/Supervisor and the Board's Representative of the commencement of The Contractor's Pre-Completion Commissioning in respect of each Phase when The Contractor (acting reasonably) considers that it shall commence The Contractor's Pre-Completion Commissioning in respect of the relevant Phase;

iii) The Contractor shall, at the times set out in the Final Commissioning Programme (and in relation to Manufacturer's Training, Induction Training and Building Familiarisation, when the Board Employees are made available for training by the Board pursuant to the Manufacturer's Training Programme, Staff Familiarisation Training Programme, Induction Programme and/or Staff Training Programme, as appropriate) undertake and complete The Contractor's Pre-Completion Commissioning in respect of the relevant Phase;

iv) The Board's Commissioning shall comprise the activities identified as such in Table A Commissioning – Outline Commissioning Programme;

v) The Contractor shall give written notice to the Board's Representative of the date upon which the Board shall be entitled to commence the Board's Commissioning in respect of each Phase, such notice to be given at least 1 month prior to the date when The Contractor (acting reasonably) considers that the Board should commence the Board's Commissioning in accordance with the Final Commissioning Programme; and

vi) The Board shall undertake and complete the Board's Commissioning for the relevant Phase, within the time period permitted within the Final Commissioning Programme, the Manufacturer's Training Programme, Staff Familiarisation Training Programme, the Induction Programme and/or Staff Training Programme (as appropriate) and shall comply with the Contractor's Site Rules and shall not cause any damage to the Works and/or Facilities or delay to the Works, in the carrying out of such activities;

c) Completion

i) The Contractor shall, no later than two months prior to the date that it anticipates (acting reasonably) a Phase will achieve the Completion Date, notify the Supervisor and the Board's Representative of such anticipated completion;

e) Post Completion Commissioning

i) The Contractor's Post Completion Commissioning shall comprise the activities identified as such in Table A Commissioning – Outline Commissioning Programme;

ii) The Contractor shall undertake and complete the Contractor's Post Completion Commissioning for the relevant Phase as follows:

- in relation to staff training, when Board Employees are made available to The Contractor for training in accordance with the Training Release Schedule, Induction Programme, Staff Familiarisation Programme and/or Staff Training Programme (as appropriate);

- in relation to clinical cleans, in accordance with the Final Commissioning Programme;

- The Board's Post Completion Commissioning shall comprise the activities identified as such in Table A Commissioning – Outline Commissioning Programme; and

- The Board shall undertake and complete the Board's Post-Completion Commissioning for the relevant Phase in accordance with the Final Commissioning Programme, Training Release Schedule, Induction Programme, Staff Familiarisation Programme and/or Staff Training Programme (as appropriate) and shall not cause damage to the Facilities in the carrying out of such activities.

e) Equipment and Training

i) The Contractor shall not clean, or move to enable general cleaning, items of equipment so identified by the Board unless in agreement with the Board's Representative. This shall include but not be limited to:

- physiological monitoring equipment;

- patient medical equipment when in use (e.g. respirators, air tanks, infusion pumps);

- department based computers, visual display units and radiographic equipment or machine consoles including anything bearing radiation or hazard Warning signs; and

- equipment that is plugged in for re-charging; and

ii) The Board shall ensure that any equipment of the Board that is transferred from an existing site is cleaned and disinfected prior to being transferred to the Facility.

OUTLINE COMMISSIONING PROGRAMME

Table A: Commissioning

Area comprised within a Phase	**Pre Completion Commissioning**		**Post Completion Commissioning**	
	The Contractor's Pre-Completion Commissioning	**Board Commissioning**	**The Contractor's Post Completion Commissioning**	**Board Post Completion Commissioning**
Rooms/areas which only contain the Contractor's equipment and movable equipment to be installed/commissioned by the Contractor in accordance with Appendix F (*Equipment*)	The Contractor to install Board Specialist Equipment as required in accordance with Appendix F2 (*Equipment*) The Contractor to commission and test equipment as required in accordance with Appendix F (*Equipment*) The Contractor to carry out Handover clean The Contractor to carry out Staff Familiarisation Training when Board Employees are made available to The Contractor by the Board for training, in accordance with the Staff Familiarisation Training Programme, Manufacturer's Training Programme,	Board to make available Board Employees for training in accordance with the Staff Familiarisation Training Programme, Manufacturer's Training Programme, Induction Programme and/or Staff Training Programme. The Board shall witness such testing as required by Approved Persons e.g.: • medical gas testing including provision of gas for such testing purposes • Clinical Cleaning in accordance with The Board's obligations as set out in the Completion Criteria of The Supervisor Contract.	The Contractor to train Board Employees made available for training pursuant to the Training Release Schedule, Induction Programme, Staff Familiarisation Training Programme and/or Staff Training Programme The Contractor to carry out Clinical Clean in accordance with the Commissioning Programme Clinical Clean of Board Equipment	Board to install, commission and test equipment as required pursuant to Appendix F (*Equipment*) and the Commissioning Programme Board to make available Board Employees for training in accordance with the Training Release Schedule, Induction Programme, Staff Familiarisation Training Programme and/or Staff Training Programme Board decant of patients to be carried out in accordance with the Commissioning Programme

Area comprised within a Phase	Pre Completion Commissioning		Post Completion Commissioning	
	The Contractor's Pre-Completion Commissioning	**Board Commissioning**	**The Contractor's Post Completion Commissioning**	**Board Post Completion Commissioning**
	Induction Programme and/or Staff Training Programme			
Rooms/areas which contain items of fixed equipment which are installed/commissioned by the Contractor and items of fixed equipment which are installed/commissioned by the Board in accordance with Appendix F (Equipment)	The Contractor fixed equipment installed, connected, commissioned and tested in accordance with Appendix F (Equipment) and the Commissioning Programme The Contractor to carry out Handover clean Completion of Works after Board Equipment installation The Contractor to insure Equipment in accordance with Appendix F (Equipment) The Contractor to carry out Staff Familiarisation Training when Transferring Board Employees are made	Board Specialist Equipment and fixed equipment installed, connected, commissioned and tested in accordance with Appendix F (Equipment) and the Commissioning Programme Board fixed equipment protected/mothballed until after the Phase Completion Date for the relevant Phase Board to protect and maintain the Board Equipment placed, and / or installed. Board to make available Board Employees for training in accordance with the Staff Familiarisation Training Programme, Manufacturer's Training Programme, Induction Programme and/or Staff	The Contractor to train Board Employees made available for training pursuant to the Training Release Schedule, Induction Programme, Staff Familiarisation Training Programme and/or Staff Training Programme The Contractor to carry out Clinical Clean in accordance with the Commissioning Programme Clinical Clean of Board equipment	Board to install, commission and test equipment as required pursuant to Appendix F (Equipment) and the Commissioning Programme Board to make available Board Employees for training in accordance with the Training Release Schedule, Induction Programme, Staff Familiarisation Training Programme and/or Staff Training Programme Board decant of patients to be carried out in accordance with the Commissioning Programme

Area comprised within a Phase	Pre Completion Commissioning		Post Completion Commissioning	
	The Contractor's Pre-Completion Commissioning	**Board Commissioning**	**The Contractor's Post Completion Commissioning**	**Board Post Completion Commissioning**
	available to The Contractor by the Board for training, in accordance with the Staff Familiarisation Training Programme, Manufacturer's Training Programme, Induction Programme and/or Staff Training Programme	Training Programme. The Board shall witness such testing as required by Approved Persons e.g.: • Medical gas testing including provision of gas for such testing purposes • Clinical Cleaning in accordance with The Board's obligations as set out in the Completion Criteria of The Supervisor Contract.		
ICT Board are responsible for installing hardware (server, PCs printers etc) and the Contractor responsible for infrastructure (containment, cabling, computer rooms etc)	The Contractor infrastructure installed, commissioned and tested in accordance with Employers Requirements (*ICT*)	Board hardware installed, commissioned and tested (Network, servers, critical clinical workstations) in accordance with Employers Requirements (*ICT*) and the Commissioning Programme	The Contractor to train Board Employees made available for training pursuant to the Training Release Schedule, Induction Programme, Staff Familiarisation Training Programme and/or Staff Training Programme The Contractor to carry out Clinical Clean in accordance with the Commissioning Programme	Board hardware installed, commissioned and tested in accordance with Employers Requirements (*ICT*) and in accordance with the Commissioning Programme Board to make available Board Employees for training in accordance with the Training Release Schedule, Induction Programme, Staff Familiarisation Training Programme and/or Staff Training Programme

OUTLINE COMMISSIONING PROGRAMME

Completion Process

A. Final Commissioning Programme

A.1 The Final Commissioning Programme shall be in accordance with the Outline Commissioning Programme and shall impose no greater or more onerous obligation on the Board or the Contractor than those set out in the Outline Commissioning Programme, unless otherwise agreed. The Final Commissioning Programme shall be developed by the Contractor in conjunction with and having consulted:

1.1.1 the Contractor;
1.1.2 the Board;
1.1.3 the Supervisor; and
1.1.4 the Board's FM Team.

A.2 The draft Final Commissioning Programme shall contain, amongst other things, full details of the following (including timing and sequence of events) for each Phase:

1.1.5 Contractor's Pre Completion Commissioning;
1.1.6 Board's Commissioning;
1.1.7 Contractor's Post Completion Commissioning;
1.1.8 the Board's Post Completion Commissioning; and
1.1.9 the Supervisor's Completion Criteria applicable to the relevant Phase.

A.3 The Contractor shall provide the Board with a draft of the Final Commissioning Programme relating to each Phase not less than 12 months prior to the anticipated Phase Completion Date.

A.4 If the Board has any comments on the draft Final Commissioning Programme, it shall issue comments on the draft Final Commissioning Programme to The Contractor on receipt of the draft Final Commissioning Programme by the Board from The Contractor, pursuant to paragraph 1.3 of this section (Outline Commissioning Programme).

A.5 If the Board raises comments on the draft Final Commissioning Programme in accordance with paragraph 1.4 of this section (Outline Commissioning Programme), the parties shall meet in good faith to discuss the terms of the Final Commissioning Programme), in order to agree the terms of the Final Commissioning Programme.

A.6 If the parties cannot agree the content of the Final Commissioning Programme, the matter shall be referred for determination in accordance with the Dispute Resolution Procedure.

A.7 Where any amendments to the scope and/or timing of the Board's Commissioning and/or the Board's Post Completion Commissioning are agreed or determined pursuant to paragraph 1.5 and/or 1.6 of this section (Outline Commissioning Programme) such change shall be treated as a Compensation Event.

OUTLINE COMMISSIONING PROGRAMME

Staff Familiarisation Training

B. Manufacturers' Training

B.1 The Contractor shall provide Technical Manufacturer's Training to such numbers of Board Employees as is agreed between the parties as being appropriate to allow for a cascade training regime, in accordance with the Manufacturer's Training Programme, which shall be submitted for agreement with the Board 4 months prior to a Phase Completion Date. The training shall be carried out prior to each Phase Completion Date, in accordance with the durations per system required pursuant to Table 1 (Outline Commissioning Programme), and in accordance with the Manufacturer's Training Programme. The Contractor shall only be responsible for those Board Employees directly trained by it. Systems requiring such manufacturer's training and thus more direct staff exposure to the manufacturer, are listed (but are not limited to those set out in) in Table 1 (Outline Commissioning Programme). The Board shall make available the relevant staff for training in accordance with the Manufacturer's Training Programme.

C. Building Familiarisation Training

C.1 Building Familiarisation Training shall be provided to each Board Employee by The Contractor to provide staff with general building and Site Familiarisation, general Site orientation and Building Health and Safety Induction. This shall be organised in small groups for half a day so that the impact on the existing sites is minimised, and subject to paragraph 2.2 below, shall comprise part of The Contractor's Post Completion Commissioning "Building Familiarisation"). The Building Familiarisation shall be programmed on a training plan, prepared by The Contractor and agreed with the Board not less than 40 Business Days of the anticipated Phase Actual Completion Date.

C.2 Board Employees at each Phase Completion Date shall receive this training leading up to their transfer, in a time period agreed with the Board and shall comprise part of the Contractor's Pre Completion Commissioning.

C.3 The Board shall make available the relevant staff for training in accordance with the Staff Familiarisation Training Programme.

D. Department Induction

D.1 Board Employees shall receive a department induction prior to the Relevant Service Transfer Date. This training (comprising two half days) shall be provided by the Contractor at the existing sites. Should the Board require this to be undertaken off site the costs associated with this shall be borne by the Board. This training shall cover department operational procedures and risk assessments.

D.2 The Induction Training shall be programmed and set out in a Training Plan with the Board Employees receiving the training in the period leading up to the Relevant Service Transfer Date. The Training Plan shall take into account the Board's responsibility for delivering the Services at the existing sites and shall therefore be designed to limit the impact on operational delivery and shall be prepared by The Contractor and agreed by the Board not less than 12 months prior to the anticipated Phase Completion Date.

D.3 The Board shall make available the relevant staff for training in accordance with the Induction Programme.

Table 1: Systems requiring staff direct manufacturers' training (to familiarise Transferring Board Employees with new plant and equipment)

Systems	CarPark Operative	Switchboard Operator	Receptionist	Helpdesk Operative	Security Officer	Porters	SoftFM Managers	SoftFM Supervisors	Energy Manager	HardFM Managers	HardFM Supervisors	Technicians	Electrical Craftspersons	Mechanical Craftspersons	Building Craftspersons	Maintenance Assistants	Administrators
Access Control	1				1		1	1									
CCTV (Operator)	1				1		1	1									
CCTV (Maintenance)										1	1	1	1				
Other Alarms	1	1	1	1	1												
Switchboard System		2	2	2													
Helpdesk System (Front Line process)		2	2	2													
Helpdesk System (Workload & record keeping process)							2	2		2	2						
Helpdesk System (Task Management & Feedback))						1	1	1		1	1	1	1	1	1	1	
Passenger Lift Evacuation (Competent Person)										1	1	1	1	1		1	
Passenger Lift Evacuation (SOP)	½	½	½	½						½	½	½	½	½	½	½	
Computer Aided Facilities Management System		2		2			2	2		2	2	2	2	2	2	2	
Asset Management System							2	2	2	2	2						
MiCAD									2	2	2	1	1	1	1		
Training in construction & operation of PPM									2	2	1	1	1	½	½	½	

Scheduling																	
AHU									1	1	1	1	1	1			
Airtube (Operator)						½	1	1			1	1	1	1			
Airtube (Maintenance)										1	1	1	1	1			
Systems	**CarPark Operative**	**Switchboard Operator**	**Receptionist**	**Helpdesk Operative**	**Security Officer**	**Porters**	**SoftFM Managers**	**SoftFM Supervisors**	**Energy Manager**	**HardFM Managers**	**HardFM Supervisors**	**Technicians**	**Electrical Craftspersons**	**Mechanical Craftspersons**	**Building Craftspersons**	**Maintenance Assistants**	**Administrators**
Auto Doors/Barriers										½	½	½	½	½	½		
BMS									2	2	2	2	2	2			
BMS Access Control (Operator)	1				1		1	1		1	1						
BMS Access Control (Maintenance)										2	2	2	2	2			
BMS Technology maintenance/trouble shooting									3	3	3	3	3				
BMS Technology Input/output Alarms & Scheduling									2	2	2	2	2				
BMS Technology - Report writing									2	2	2						
BMS Energy Management & metering functions									3	3	3	1	1	1			
Boilers MTHW									1	1	1	1	1	1			
Chillers/Local DX Units									1	1	1	1	1	1			

CHP									1	1	1	1	1	1			
Fire Systems	1	1	1	1	1					2	2	2	2	2	2		2
Generators									½	1	1	1	1	1			
Systems	**CarPark Operative**	**Switchboard Operator**	**Receptionist**	**Helpdesk Operative**	**Security Officer**	**Porters**	**SoftFM Managers**	**SoftFM Supervisors**	**Energy Manager**	**HardFM Managers**	**HardFM Supervisors**	**Technicians**	**Electrical Craftspersons**	**Mechanical Craftspersons**	**Building Craftspersons**	**Maintenance Assistants**	**Administrators**
Refrigeration									1	1	1	1	1	1			
Security Systems (Operational)	1			1	1		1	1		1	1						
Security Systems (Maintenance)										1	1	1	1				
Renewable Energy resources – where provided				1		1			3	3	3	3	3	3	1	1	
Decontamination – RO Plant operation & maintenance.				1		1			1	1	1	1	1	1	1		
Sterilisers/Washer Disinfectors										1	1	1		1			
Switchgear HV											1	1					
HV infrastructure and operation											1	1					
Switchgear LV										1	1	1	1				
LV infrastructure and operation										1	1	1	1				

UPS/Battery Cubicles										½	½	½	½				
MGPS infrastructure and operation										1	1	1		1			
Robotics							1			1	1	1	1				
Nurse Call											1	1	1				

6.8.3 Handover Procedures

6.8.3.1 The Contractor's Commissioning Programmes to include for sign off of relevant Testing and Commissioning elements by other parties, e.g.:

a) Board Approved Parties

i) Fire Officer;

ii) Control of Infection Officer;

iii) Radiation Protection Officer; and

iv) Medical Gases Officer;

b) Supervisor; and

c) Independent Commissioning Engineer

6.8.3.2 It will be the Contractors responsibility to programme the above sign off requirements to ensure relevant Completion Date achieved.

6.8.3.3 In connection with the above, the Supervisor will expect the Contractor to provide the following documentation in connection with Handover/Completion;

6.8.4 General

6.8.4.1 General Requirements

The Contractor shall provide such labour, materials, stores, test equipment, tools, instruments, apparatus and assistance as are reasonably required for the purpose of the inspection by the Supervisor and shall be responsible for the provision of such electricity, fuel, water and other consumables and materials as may be reasonably required for the same. Invitations shall be furnished to the Board, its Project Manager and the Supervisor to witness such works inspections, testing and commissioning activities as the Board deems necessary. Adequate notice of testing shall be given.

6.8.4.2 The Contractor shall ensure that major items of plant shall be tested at the works for both performance and safety prior to dispatch. Major items of plant shall include, but not be limited to, the following: boiler plant, generators, chillers/refrigeration machinery, large pumps, HV/MV switchgear, large pressure vessels etc. The Contractor shall arrange to witness all factory testing and shall furnish the Board, its Project Manager and the Supervisor with the opportunity to witness all factory testing, and sign off marked items of Plant and Materials. The Board, its Technical Advisors and the Supervisor shall be given at least fourteen days notice of such testing.

6.8.5 Works inspection, testing and acceptance activities

6.8.5.1 Completion Criteria

6.8.5.2 The Contractor shall demonstrate that the following criteria have been achieved:

6.8.5.3 The building is structurally complete, all external fabric is complete and internally all the finishes are complete in accordance with the ADB Room Data Sheets;

6.8.5.4 All incoming Utilities including all associated back up systems is tested, commissioned and operational;

6.8.5.5 The Mechanical and Electrical plant and systems operate satisfactorily in accordance with the specified design criteria, and the ADB Room Data Sheet;

6.8.5.6 The Building Management System is complete, tested, commissioned and operational;

6.8.5.7 All furniture and equipment shown on the Loaded Room Layout drawings (as supplemented by Appendix F (Equipment) have been installed (and commissioned if appropriate);

6.8.5.8 The Board has been supplied with keys, access codes, swipe cards and other access devices for access to and within the Works;

6.8.5.9 Safe access and egress to and within the relevant Laboratory and Hospital sites has been established;

6.8.5.10 The relevant Laboratory and Hospital sites shall be free from all surplus materials, plant and equipment that could materially affect the completion of the Tests on Completion and shall comply with the standards and requirements of Section 3;

6.8.5.11 All internal and external drainage systems are installed and are operational;

6.8.5.12 External works as appropriate have been completed and are available for use by the Board;

6.8.5.13 All hard-landscaped external works, including roads, car parks, pavements and boundary walls/fences are complete and available for use by the Board;

6.8.5.14 Lift and Escalator systems are complete, commissioned and operational;

6.8.5.15 All building directional departmental, general information and room numbering signage as indicated within Employers Requirements/the Contractor Proposals and/or Reviewable Design Data and necessary to all the operational Services to commence has been provided and installed. This includes both internal and external signage;

6.8.5.16 The Fire Management Strategy has been finalised, The Contractor to complete and submit fire safety risk assessment in accordance with the Fire (Scotland) Act 2005;

6.8.5.17 The Fire Detection, Alarm and Suppression Systems are complete, tested commissioned and operational

6.8.5.18 All External Lighting is installed, tested, commissioned and operational;

6.8.5.19 All IT and Communication Systems are complete, tested, commissioned and operational;

6.8.5.20 All Security and Surveillance Systems, Access Controls and Call Alarms are complete, tested, commissioned, operational and available for use by the Board;

6.8.5.21 Acoustic Testing has been completed to prove compliance with the Employers Requirements and the Contractor Proposals;

6.8.5.22 The medical gas and vacuum system is complete, tested, commissioned and witnessed by NHS Greater Glasgow and Clyde's Chief Pharmacist and Medical Gases Approved Person;

6.8.5.23 A proving and training period for the Board has been offered by the Contractor, and subject to the Board making themselves available within agreed timescales, this training has been completed;

6.8.5.24 A proving and training period for the Service Provider has been completed;

6.8.5.25 The Contractor has provided all documentation to the Supervisor in accordance with the Supervisor's Contract and Section 4; and

6.8.5.26 A draft hard copy and electronic format of the relevant As Built Specification Documents, Operational & Maintenance Manuals and Health & Safety Files for the Facilities (containing, as a minimum, all the testing and commissioning information so far as it is reasonably practicable) have been issued by the Building Contractor.

6.8.6 Clinically clean

6.8.6.1 On completion of the Works, The Contractor shall provide the Facilities as "clinically clean" in accordance with NHS Scotland National Cleaning Services Specification and to the satisfaction of the NHS Greater Glasgow and Clyde's Control of Infection Officer.

6.8.7 Testing and commissioning documentation

6.8.7.1 All documentation associated with the Tests on Completion shall be collected and collated by the Contractor/Independent Commissioning Engineer and shall be presented as a bound, indexed document to the Board. The following list is indicative of the test documentation expected to be provided:

Test Documentation
Building Warrant Completion Certificates
Evidence that all Conditions attached to the detailed Planning Consent have been discharged to the satisfaction of the Local Authority.
Roads Construction Consents
Design Warrants
Flushing Cleaning and Chlorination test certificates
Boiler Plant Manufacturers Factory Test and Commissioning Sheets in accordance with CIBSE Commissioning Code B, including all steam systems
Ductwork Systems pressure test and volume flow rate Certificates
Laundry Equipment Commissioning Certificate
Kitchen Equipment Commissioning Certificate
Electrical Installation Completion and Inspection Certificates in accordance with BS 7671 and

Test Documentation
NICEIC requirements
Robotics Equipment Commissioning Certificate
Lighting and Power Certificate of Test
Fire and Intruder Alarms Commissioning Certificates, including intruder detection and alarm, access control system(s)
General Electrical Earth Loop and Insulation Resistance Test Sheets
Testing of all hot water service thermostatic mixing valves (TMV's) in accordance with BS6700 and tests to comply with HSE Document L8 and HGN 'Safe Hot Water and Surface Temperatures
Emergency Lighting Completion and Test Certificates
Certificate of Compliance/Testing of Radiation protection
Security Systems Commissioning Certificates
Certificate of Soundness Testing of Gas Installation
Gas Pipework Pressure Test and Purge Certificates
Medical Gas Pipework Pressure Test and Purge/Commissioning Certificates
Fire Suppression System Certificates (in accordance with BS6266 and tests to comply with CIBSE Guidance E)
Fire Alarm Sound Record Sheets
Lighting Calculation Sheets and Lux Level Test Results (Internal & External)
Machine (Generator/UPS/CHP etc) Specialist Commissioning and Factory Test Sheets
Acoustic Test sheets (in accordance with BS 5821)
Lift Commissioning in accordance with BS EN 81 and Factory Test Sheets
Lightning Protection Risk Analysis and Test/Commissioning Sheets
Boiler Plant Manufacturers Factory Test and Commissioning Sheets in accordance with CIBSE Commissioning Code B
Works pressure test certificates for all pressure vessels
Mechanical Pipework Systems Pressure Tests
A/C Equipment Performance Tests
Condensate Clearance Tests for A/C Equipment
BMS/EMS Tests/Commissioning Records in accordance with CIBSE Commissioning Code C
Air Distribution Systems in accordance with CIBSE Commissioning Code A
Water Systems (heating & domestic water) in accordance with CIBSE Commissioning Code W
Legionellae Testing (to include an organic check on the incoming mains) within tolerances given in HSE ACOP test sheets
Domestic water systems bacteriological quality test sheets
Rainwater harvesting systems test and completion and bacteriological quality test sheets
Plant (Calorific, Treatment etc.) Specialist Commissioning and Factory Test Sheets
Nurse Call Test Certificate
Disabled Toilet Alarm Test Certificate
Fire Alarm Test Certificate
CCTV and Access Control Test Certificate
TV Aerial Certificate
Patient Entertainment System Certificate
Telephone Cabling Test Certificate
ICT Cabling Test Certificate
Induction Loop Test Certificate
Pipeline Pressure and flowrate Test Certificates including drainage and all steam systems
Steam boiler/generator test factory test and commissioning certificates in accordance with

Test Documentation
CIBSE Commissioning Code B
Ground Source Heating installation pressure and Test Certificates
Chiller factory test and commissioning certificates in accordance with CIBSE Commissioning Code R
Chemical clean and inhibitor dosing certification to heating/chilled water systems
Ductwork physical and bactericidal cleaning certification

Section 7.0 Architectural Requirements

7.1 Masterplan

7.1.1 The Masterplan for the New South Glasgow Hospitals has been developed in consultation with various stakeholders, including User Groups, Architecture + Design Scotland, the Carbon Trust, Strathclyde Passenger Transport, Civil Aviation Authority (CAA) and Glasgow City Council Planning Department. The aims of the Masterplan are to achieve a clarity of spaces and routes within the existing Southern General Hospital Site.

7.1.2 The proposed Masterplan design seeks to improve the entrances to the site, traffic flows around the site and enable all visitors to the new hospitals to orientate themselves quickly with the campus. A new main boulevard entrance will be created from Govan Road, which will border the new Laboratory, FM & Mortuary and Energy Centre Site. However, the traffic flows have been separated and all service access to this area will be off Hardgate Road. Public Access and drop off via private car become immediately clear on the approach to the building and the traffic flows allow drop off adjacent to the relevant entrances and then onwards to the respective car parking zones. A new transport 'hub' located centrally on the site provides direct and sheltered access to the new hospital entrance. This hub will allow 'Fastlink', taxi and private car drop off within immediate walking distance to the entrances. Public Bus routes will remain on the existing road network with additional bus stops being provided at key entrances.

7.1.3 Blue Light traffic routes into and within the site are clearly identified and provide the quickest access points from whichever direction the ambulance approach.

7.1.4 Upgrading and Replacement of car parking provision has located 4 new major car parks strategically around the site:

a) Adult Hospital x 2nr;

b) Children's Hospital; and

c) A&E Entrance

7.1.5 Pedestrians and cycle routes through the site and the interaction with the building have been developed to provide clear designated routes to the new main hospital and surround buildings, while the punctuation of the site with pockets of landscaped spaces supplement the main park area situated immediately in front of the new main hospital entrance. The 'green space' within the campus is designed to provide a functional retreat for patients, visitors and staff.

7.1.6 As the final design develops within the parameters of the Masterplan, there is a requirement to update the Development Control Plan for the entire Southern General Site to identify future uses, expansion and redevelopment.

7.1.7 The Masterplan presents the Board's vision of the New South Glasgow Hospitals on the Southern General Hospital Site and requires to be followed and implemented by the Contractor.

7.2 Exemplar Design

7.2.1 The exemplar design has been developed in consultation with the Board and User Groups. The exemplar design is intended to reflect these discussions and provide an advanced level of briefing that will enable the Contractor's response at the end of the bid period to be more advanced in terms of understanding of the Board's and User's functional, clinical and quality requirements. As well as reflecting the requirements of the Clinical Brief the design exemplar is also intended to represent a design quality benchmark against which the Contractor's proposals will be measured. The exemplar demonstrates the aspirations of the Board in terms of the graphical and technical representations of the Contractors.

7.2.2 Whilst the exemplar design has not been developed with the intention of constricting the Contractor's proposals to a particular solution nor has it been developed in order to stifle innovation or creativity, it should be noted that the functional relationships indicated in the exemplar does represent the culmination of a process of detailed consultation with the Board and Users to determine their requirements and as such it is not expected that the Contractor will require to revisit the functional relationships or design principles as set out in the following exemplar information;

a) 1:500 departmental relationship drawings for all levels of each building indicating functional relationships, entrances and main circulation routes (Appendix H);

b) 1:200 departmental drawings for 7 no. key departments in the Adult's Hospital and 4no. key departments in the Children's Hospital indicating room adjacencies, circulation layouts, corridor widths, entrances and links to other departments/facilities. (Appendix I);

c) 1:50 Room Layout Drawings indicating clinical functionality, room size and shape and compliance with ergonomic data. (Appendix J); and

d) ADB Room Data Sheets (Appendix E).

7.2.3 Described in more detail below are the key features of the exemplar design which will require particular consideration by the Contractor;

a) Adult and Children's Hospital Identity;

b) Podium;

c) Ward Tower;

d) Main Entrance; and

e) Atrium including retail space;

Adult and Children's Hospital Identity

7.2.4 The exemplar proposes a single overall building footprint subdivided into the Adult and Children's facilities, creating two distinct but adjoining hospitals. This is in acknowledgement of the benefit to be exploited through the co-location of the Adult and Children's Hospitals, a great deal of consideration has been given to identifying these in the brief and in the design of the two hospitals.

7.2.5 It is important to stress that the Children's Hospital will operate as a hospital in its own right with its own clinical staff and management, with some shared facilities. It is therefore a requirement of the brief for the Children's Hospital not only that there should be an appropriate degree of clinical and patient separation between the two hospitals but also that the distinct identity of the Children's hospital shall be maintained both externally and within the patient and public areas. This requirement is expressly reflected in the exemplar design which indicates two separate entrances for the Adult's and Children's Hospital.

Building Typologies

Podium

7.2.6 A significant proportion of the overall building footprint is dedicated to integrated acute facilities which will be housed in the 3 storey podium. The podium will house such departments as Operating Theatres, Radiology, Critical Care and Outpatients Departments. The key drivers behind the location of departments are the necessities of co-location for functionality along with appropriate public/private zoning of the facilities. For example Outpatients and Accident Emergency Departments are located on the ground floor towards the external boundary of the footprint to ensure an appropriate level of public accessibility is achieved while the core of the footprint is reserved for private treatment and diagnostic areas such as Radiology.

7.2.7 Departments located in the podium;

a) NSGH Main Entrance and Discharge Lounge;

b) NSGH Emergency Department;

c) NSGH Rehabilitation;

d) NSGH Radiology;

e) NSGH Acute Assessment;

f) NSGH Critical Care;

g) NCH Main Entrance;

h) NCH Emergency Department;

i) NCH Rehabilitation;

j) NCH Radiology;

k) NCH OPD;

l) NCH Cardiology;

m) NCH Inpatient Wards;

n) NCH DCFP;

o) Operating Theatres;

p) Endoscopy;

q) Aseptic Suite;

r) Renal Dialysis;

s) Nuclear Medicine;

t) Medical Physics;

u) Dining Area;

v) Retail and Café; and

w) Pharmacy.

Ward Tower

7.2.8 Located above part of the footprint of the podium will be the 13 storey 4-wing ward tower providing single bedroom ward accommodation across a range of departments including Renal, Vascular, Haemato-Oncolgy etc. In total the facility includes the provision of 1,109 adult and 240 children's beds. While not all bed spaces noted will be accommodated in the ward towers, the ward tower typology was developed as being the most appropriate and achievable method by which these bed numbers could be accommodated. The towers are positioned and orientated to provide best use of views across the site, provide appropriate levels of natural light and to achieve patient privacy by preventing overlooking from other ward accommodation.

7.2.9 Tower Wards include;

a) Generic wards;

b) Haemo-oncology wards;

c) Vascular wards;

d) Renal wards;

e) Dermatology; and

f) Stroke;

Main Entrance

7.2.10 There are 6 staff/patient/visitor entrances on the ground floor;

a) NSGH Main Entrance;

b) NCH Main Entrance;

c) NSGH 24 Hour/Staff Entrance;

d) NCH 24 Hour/Staff Entrance;

e) NSGH Acute Assessment Entrance; and

f) NSGH / NCH Emergency Department Entrance

7.2.11 At each of the above entrances a robust glazed canopy will require to be incorporated in order to provide shelter from the elements for staff, visitors and patients and to assist in the prevention of wet contamination of flooring within the building. Entrance canopies will require to be sized appropriately to accommodate ambulances as necessary. A methodology for the maintenance and cleaning of the canopies will also be required.

7.2.12 The ambulance entrance of the Emergency Department (ED) will be expected to have the ability to be converted into an external decontamination facility. This would include the requirement to incorporate roller screens as part of the ambulance canopy and multiple water mixer points to allow shower attachments. The area will also require the ability to isolate drained water under decontamination procedures.

7.2.13 The main entrances to the Adult's and Children's Hospitals will be expected to have a light, spacious and welcoming atmosphere and the main entrance shall be immediately apparent to all users. The main entrances for the Adult's and Children's Hospitals should reflect in form, scale, space and use of materials the aspirations and design quality promoted by the Board resulting in a meaningful expression of the Board's intent for the facility; that is to deliver first class healthcare to the local population and provide a focal point for community activities and education welfare. The entrances should demonstrate the required benchmark of architectural design quality while at the same time incorporating practical considerations, for example the provision of appropriate shelter and adequate accessibility of entrances.

7.2.14 The façade of the main entrances should be fully glazed for the full height and width of the entrance area including automatic sliding entrance doors to allow views in and out of the main entrance and reception. It is important that large glazed areas such as this should be clearly identified as such for safety purposes and must be safety glass. Solar shading devices should be incorporated as necessary to achieve the Board's stated Sustainability and Energy Targets. The size and numbers of automatic entrance doors should be sufficient for the expected number of users to pass comfortably and safely through them. A glazed canopy should be incorporated in order to provide shelter across the full width of the entrance at a height that provides appropriate shelter while also coordinating as required with the façade design. The structure and glass forming the canopy shall be robust and shall incorporate all appropriate standards of security, and where reasonably practicable, limit the potential for exposure to crime and vandalism.

7.2.15 Entrance lobbies should be provided as Section 7.5.2 including the requirement for a minimum of 6 metres of barrier matting to prevent the ingress of dirt and wet contamination to flooring. Any lobby enclosure provided requires to be fully glazed to allow users to proceed safely and confidently.

7.2.16 Once inside the building the reception areas and information points are key to orientation. The tone of a building is set by the entrance and reception to the building, therefore the Contractor's design should achieve a balance of openness with patient confidentiality and staff safety, resulting in reception areas skillfully combining a friendly welcome with low-key oversight of public areas. The expected quality of the main entrance spaces should be akin to a large hotel foyer, this expectation should be reflected in the choice of quality robust materials for flooring, walls, ceilings, balustrades etc. The quality of the space should also be enhanced by interesting shapes and forms, lighting techniques and the incorporation of art.

7.2.17 The reception area and main entrance generally will be busy places, both in terms of footfall and hours worked. Materials, finishes and furnishing therefore need to be robust, as well as attractive. The Contractor's design should cater for well selected, fit for purpose furnishings which will complement a clear approach to design. One such component of the main entrance design is the flooring, it is vitally important that the floor finish in the main entrance area should combine robustness and attractiveness with slip resistance. A material such as natural stone/ceramic tiles which have a high micro-surface roughness should be used.

7.2.18 One of the most important features of the reception area is the reception desk which should be close to the entrance and should be an open well lit counter/desk with a feature or identifying sign at high level. The reception counter requires to reflect and enhance the quality of the surroundings in terms of form, quality of materials and lighting.

7.2.19 In order to provide staff, patients and visitors with access to information especially at the key points of entry to the Building it is the Board's intention that Contractor's should incorporate electronic information points utilising touch-screen technology in addition to the manned reception points and stations and the PA system. These information points should present information (in a variety of languages) on the hospital for orientation and wayfinding purposes along with information in relation to the public transport hub which should be adjacent to the main entrance giving real time information on bus/fastlink timetables. The Contractor will be required to provide a clear strategy for the provision of these information points.

7.2.20 The main entrance requires to incorporate well planned waiting rooms which can help to relax patients, thereby reducing fear and increasing confidence. Upholstered seating set out in the style of a hotel foyer with spacious waiting should be the goal, these areas allow patients, carers and visitors to relax, chat, wander or simply enjoy the space and any views afforded. This is especially valuable where the patient may be accompanied by friends or relations.

A Changing Places facility which combines a toilet, shower and changing room for use by people with complex and multiple disabilities will require to be located at the Adult and Children's entrances. The space should be provided in accordance with the requirements of BS8300:2009 item 27 and should incorporate an adjustable changing table and fixed track hoist system.

7.2.21 A requirement throughout the hospital especially within entrance areas shall be to incorporate appropriate standards of security, and where reasonably practicable, limit the potential for exposure to crime and vandalism. Guidance is provided in HFN05 -"Design against crime-a strategic approach to hospital planning".

7.2.22 Atrium including retail space

a) The exemplar indicates a linear atrium linking the main entrances of the Adult's and Children's Hospitals. This concourse performs a number of different functions;

b) Provide a link between Adult and Children's Hospitals;

c) Provide clear horizontal and vertical links to all areas of the hospital facilities with the incorporation of stairs, lifts and escalators as necessary;

d) Provide a clear route for patients, staff and visitors to frequently attended departments such as the outpatient's department;

e) Provide access to pharmacy;

f) Provide access to retail facilities such as the cafeteria to allow users to purchase drinks, food and to consume them in a pleasant and relaxing environment;

g) Continue the quality of the main entrance spaces which will be reflected in the choice of quality robust materials for flooring, walls, ceilings, balustrades etc; and

h) Provide opportunities to incorporate art, lighting techniques and tv/video display screens to enhance the quality of the space and provide a welcome distraction.

7.2.23 The multi-level linear atrium space will be formed between the outpatient department and the remainder of the departments contained in the podium such as day surgery and radiology. The atrium will contain link bridges, escalators, lifts and stairs providing all vertical and horizontal communication links across the void space providing the necessary connections between departments. The lifts should be fully glazed to all sides providing views over the atrium space for the purposes of orientation. A high level of finish will be expected for all stairs and balustrades, any handrail, barrier or guarding to stairs or corridor links should be glazed to allow views for children and those in wheelchairs. The roof to the atrium should be fully glazed to provide a light, bright welcoming environment. Solar shading devices should be incorporated as necessary to achieve the Board's stated Sustainability and Energy Targets. The atrium will also provide fully glazed areas of façade to courtyards where available, to allow users views out to external landscaped courtyard spaces. The expected quality of the atrium concourse space should be akin to a high quality shopping mall and continue the quality of the main entrance. This should be reflected in the choice of quality robust materials for flooring, walls, ceilings, balustrades etc. The quality of the space should also be enhanced by interesting shapes and forms, lighting techniques and the incorporation of art.

7.2.24 The form of the atrium shall clearly express the individuality and special nature of parts of the Works including the retail facilities, yet the parts should harmonise with the facilities as a whole. The Contractor should give particular consideration to the architectural composition and expression of the form within the atrium which should reflect an identifiably distinct character for the Adult Acute and Children's Hospital as befits the nature of the patient groups.

7.2.25 The atrium also provides opportunities for retail facilities including pharmacy and cafeteria facilities, these areas should be clearly expressed.

Helipad

7.2.26 The Contractor will require to provide a rooftop Helipad and the associated services, access requirements and safety facilities in full compliance with the following guidance;

a) HBN 15-03 – Hospital Helipads;

b) British Helicopter Advisory Board – Helicopter Site Keepers Guidance Document; and

c) Structural Design Criteria - ICAO Heliport Manual

7.2.27 The Helipad will also require to be provided in line with all requirements of Glasgow City Council Planning Department including the following requirement;

a) A detailed noise and environmental assessment regarding the relocation of the heliport landing area shall be submitted to the Planning Authority for its written approval prior to its siting and operation. The Contractor requires to consult the Director of Land and Environmental Services, Public Health Unit concerning the methodology and approach to any assessment.

7.2.28 It is understood that this type of Helipad does not require to be licensed by the CAA (Civil Aviation Authority), however due to the congested nature of the surrounding area the Helipad operator will require a Rule 5 permission from the CAA and therefore the Contractor must consult the Operator and Board to ensure compliance.

7.2.29 The Helipad Operator(s) and Board will require to be consulted on the type of helicopters that will be expected (including size and weights). However as general guidance for the size of Helipad required a rectangle with sides at least 25 m long (or a circle at least 35.4 m in diameter) will be a minimum requirement to accommodate all helicopter types likely to make use of the facility.

7.3 Ceilings Heights & Voids

7.3.1 The floor to ceiling heights, or to services level where there are no ceilings, shall be designed to accommodate the nature and use of the accommodation, but as a minimum shall be at least 2700mm irrespective of location. The ADB room data sheets define ceiling heights on a room by room basis.

7.3.2 All circulation and communication spaces shall have a minimum ceiling height of 2700mm;

Room Type	Department	Minimum Ceiling Height
All Corridors	Wards	2700mm
Lift Lobbies	All Departments	2700mm

7.3.3 Certain special types of room should be 3000mm or above in height to suit their medical or equipment needs;

Room Type	Department	Minimum Ceiling Height
All Operating Theatres	All Departments	3000mm Where Laminar Flow curtains are present – 2100mm required to u/side of curtain from ffl.
Radiology and scanning Rooms (CT and MRI)	Radiology	3000mm
Endoscopy Rooms	Endoscopy	3000mm
Therapy Room	Rehabilitation	4500mm

7.3.4 Additionally there are a number of departments where all ceiling heights should be as a minimum 3000mm – including all main communication and interdepartmental circulation routes;

Department	Minimum Ceiling Height
Operating Theatres	3000mm
Critical Care	3000mm
Imaging	3000mm
Rehabilitation	3000mm

7.3.5 The following criteria require to be incorporated in the Contractor's Proposals:-

a) Areas such as circulation spaces, patient corridors, waiting areas, reception areas, entrance areas and atria should be given particular consideration in terms of ceiling form, material and with particular regard to maximising the height of ceilings to offer a light, spacious and welcoming character. For the avoidance of doubt a suspended ceiling tiled solution throughout will not be acceptable in these areas. Where higher ceilings are present a maintenance strategy will require to be clearly demonstrated;

b) An appropriate and safe void allowance above all ceilings shall be provided, including appropriate and safe points of access for maintenance of services. The void allowed shall be adequate for the full co-ordination and installation of engineering, cabling (including IT)

and other services. Co-ordination with the electrical, mechanical and communication services shall be an inherent part of the ceiling and building design. A full and appropriate strategy for the coordination of services requires to be clearly demonstrated to the Board through the use of 3D Modelling techniques;

c) It is imperative that the Contractor shall demonstrate their solution to the above requirement to the satisfaction of the Board by providing a clear and identifiable strategy for the installation of these services , providing satisfactorily accurate sizing and positioning for ducts , cable trays etc, including access points in plan and section to confirm compliance with this key Board requirement. As part of this requirement a clearly identifiable zoning strategy will require to be demonstrated by the Contractor regarding the location of access points to ceilings or roof voids;

d) The Contractor shall also ensure that the ceiling voids are designed to accommodate the specific requirements of the fire strategy for the Facilities -and in particular, the provision of cavity fire-barriers within compartments;

e) Services access through all Category 1 ceilings will not be acceptable (ceiling categories will be as defined in the ADB Room Data Sheets). For these areas the ceiling services should be capable of being accessed from an adjoining activity space. For the avoidance of doubt services should not be accessed from below (i.e. through the ceiling) in these areas. The following list of areas is indicative only and not exhaustive;

i) Aseptic suite;

ii) Decontamination unit;

iii) Operating theatres;

iv) Anaesthetic rooms;

v) Plaster room;

vi) Post operative recovery; and

vii) Preparation;

f) Ceiling or roof voids must not be accessible to patients or visitors. Access will be by Maintenance personnel only;

g) Modular ceilings are not acceptable in the operating theatre but may be required in associated areas for maintenance purposes. The ceiling in the operating theatre should also be able to withstand regular washing and have a completely sealed finish to maintain microbiological standards in compliance with SHTM, SHPN, HBN guidance;

h) If an acoustically absorbent ceiling is considered in any location it is essential that this does not present an infection hazard in compliance with SHTM, SHPN, HBN guidance;

i) Designated access points shall be fitted with a self-contained Ramsey-style ladder or similar where appropriate to facilitate access for maintenance purposes – this should be clearly demonstrated in the Contractor's approach to access and maintenance;

j) Demountable suspended ceilings shall be readily demountable without suffering undue damage and shall be capable of being easily cleaned;

k) Ceilings will be constructed in a proprietary suspended plaster board system in areas demanding specific hygiene criteria as defined in the ADB Room Data Sheets;

l) Ceiling mounted booms required for patient support and monitoring systems in theatres, treatment or x-ray rooms shall be co-ordinated with the ceiling layouts. E.g. Background fixings within ceiling void. Access to check and maintain fixings to all structurally mounted equipment requires to be provided by the Contractor in a clearly demonstrated strategy;

m) In line with the requirements of HAI Scribe coving will be required at the junction of wall and ceilings within all theatre suites and endoscopy rooms;

n) A minimum of 2100mm clearance is required under any suspended fixtures e.g. Signage;

o) The protrusion of light fittings, radiant panels or any other fittings will not be accepted in clinical areas;

p) Consideration may be given to making use of the ceilings to provide additional natural light by way of roof-lights. However, careful consideration should be given to the implications of incorporating these, e.g. rain noise, and to how they will be cleaned;

q) Emergency egress from roof void areas into patient areas is not acceptable (this includes any garden areas internal to the facility);

r) Suitable service maintenance walkways, incorporating handrails, shall be provided within roof voids with access hatches where walkways pass through fire barriers. Services require to be entirely clear of this walkway;

s) Floor to ceiling heights must be carefully considered in relation to the overall height restriction placed on the building by the granted Outline Planning Consent; Additionally floor levels are required to tie in with adjacent building levels where clearly required e.g. Neonatal;

t) Where Laminar flow canopies are present, a height of 2100mm will be required from finished floor level to the underside of canopy curtain for headroom; and

u) Washable ceilings are required in all clinical areas.

7.4 **Corridor Widths**

7.4.1 The table below identifies the Board's minimum requirements for corridor widths on a departmental basis with which the Contractor must comply;

Corridor Type	Department	Minimum Corridor Width (clear between handrails)
Hospital Street	Communication	Requirements for Means of Escape will dictate width – however minimum of 3000mm required
General Traffic – Staff Only	All Departments	1500mm
General Traffic – Patient Areas	All Departments	1800mm – two independent wheelchair users to pass
Patient Bed/Trolley Traffic	Wards	2150mm – straight movement with passing places width 3330
Patient Bed/Trolley Traffic	Theatres/Endoscopy	2960mm – two beds to pass regularly
FM Tunnel	Links buildings	8000mm - to be developed with robotics design and requirement.

7.4.2 Corridor widths shall be as required by the nature and use of the accommodation. Minimum widths shall apply along the whole length of the corridor. Main interdepartmental corridors in areas that patients may travel in beds shall be of sufficient width to allow two beds, with any attached equipment, to pass. Departmental corridors shall have passing places and all corridor widths shall be subject to specific agreement with the Board.

7.4.3 The following criteria require to be incorporated in Contractor's proposals:-

a) the utilisation of corridor widths and profiles is an integral element of the Clinical Brief and requires to be addressed in design solutions. This may be achieved through the use of informal seating areas and the like, whilst avoiding areas where patients may be obscured from staff view where possible;

b) corridors in patient areas shall not be less than 1800mm (clear between handrails or other protrusions), with corner protection to be provided and handrails to both sides, where appropriate as defined in Section 7.16 - Protection;

c) wherever possible reduce lengths of circulation routes and provide open areas and stopping/resting points along the length of travel;

d) avoid isolated columns in open plan areas or on circulation routes where practicable; and

e) avoid dead ends to circulation routes, particularly in patient areas;

7.5 **Doors**

7.5.1 Door widths shall be identified in the relevant ADB Room Data Sheet and Schedule of minimum door widths below (in the eventuality of a conflict between the RDS and Schedule below the wider provision will apply).

Room Type	Department	Minimum Coordinating width of Door
Ensuites	All Departments	1980 mm
Recovery	Operating Theatre	1900mm
Corridors	All Departments	1900mm in corridors greater than 1800mm wide i.e. Corridors with patient access
Operating Theatre	Operating Theatre	1900mm
Endoscopy Room	Endoscopy	1900mm
Assisted Bathrooms	All Departments	1500mm
Patient Bedrooms	All Departments	1500mm
Treatment Rooms	All Departments	1500mm
DSR	All Departments	1500mm
Disposal Hold	All Departments	1500mm
Equipment Store	All Departments	1500mm
MRI Room	Imaging	1450mm (refer to HBN 06)
Interview/Sitting Rooms	All Departments	1000mm
Consult/Exam Rooms	All Departments	1100mm
Clean/Dirty Utility	All Departments	1000mm
Offices	All Departments	1000mm
Seminar Rooms	All Departments	1000mm
General Stores	All Departments	1000mm
Staff Rest Rooms	All Departments	1000mm
Staff WC	All Departments	1000mm
Patient WC	All Departments	1100mm

7.5.2 For the avoidance of doubt, the minimum coordinating width indicated above is as defined in SHTM.

7.5.3 Notwithstanding the above, the Contractor shall be responsible for establishing, through detailed consultation with the Board, additional specific requirements for door widths in all areas of the Works. Consideration shall be given to providing sufficient door width in areas where the Board's operations rely on the use of larger items of Equipment such as waste containers and regeneration trolleys.

7.5.4 Door widths and door configuration shall be provided to allow for the delivery and removal of Equipment to each area. The Contractor shall require to demonstrate replacement planning for

major items of kit including navigation routes through corridor and other doors (e.g. replacement Imaging equipment). In this respect the Contractor shall ensure that the relevant corridor and door opening widths can accommodate the replacement of plant and materials along designated routes (identified by the Contractor). This to allow the passage of new/replacement Equipment and Specialist equipment without the need for the removal of any doors, door operating gear/equipment or handrails/protection.

7.5.5 The following criteria require to be incorporated in the Contractor's proposals:-

a) doors from the single bedrooms to en-suites in all ward accommodation should comply with the requirements of both HBN 04-01 Adult Inpatient facilities and HBN 00-02 Sanitary Spaces. The double door to the shower room should consist of a sliding/folding door and a hinged door. The sliding/folding door provides staff and unassisted patient access. Both doors need to be fully open for assisted use of the facilities. The sliding/folding door should be designed to release from the overhead track in order to provide mobile hoist access to the room and transfer to one side of the toilet. The hinged door should be able to open unhindered. To maximise the free space in the bedroom, consideration should be given to making this a folding door;

b) doors will require to accommodate overhead tracks (including supporting structures as necessary) for patient hoists in all bedrooms, with patient hoists to be installed in six bedrooms per ward generally and all bedrooms in elderly wards as well as in one room per OPD cluster in the Children's hospital;

c) all main entrance doors shall be automatically operated with break-out facility in the event of fire and have an effective draught lobby;

d) internal door leaves to all areas shall be of solid core construction, reinforced with damage protection plates; They must be resistant to all damage which would be reasonably expected for the building use. In line with BS8300 requirements the Board would expect that as a minimum all doors where there will reasonably expected to be wheelchair access – 400mm high kickplates will be provided. Refer to Section 7.16 - Protection for further details;

e) doors to some rooms shall be of a security rated construction, particularly areas where medical drugs are likely to be stored as indicated in ADB Room Data Sheets;

f) all door frames must be of solid or metal construction, and must be securely fixed in to the adjoining construction;

g) all doors to bedded areas shall be minimum width of one-and-a-half size openings to allow access for hospital beds, with double width doors required in ward area corridors. In addition to the requirements of the Disability Discrimination Act, careful consideration needs to be given as to the clear opening size of doors due to the need to transport patients and items through. Patients may be supervised, with an individual on either side of them (some patients may be evacuated in their bed to a place of safety, therefore pinch-points at rooms and corridors need to be avoided);

h) doors shall incorporate vision panels as per the ADB Room Data Sheets, to permit staff observation; of these, some will require integral blinds to obscure the vision panel for privacy reasons, this will also be indicated in ADB Room Data Sheets. Integral blinds to the vision panel are to be operable only from the inside of the room where a member of staff will

be constantly present, where a member of staff will not be constantly present (bedrooms for example) the integral blind should be operable form both inside and outside the room. Integral blinds in door vision panels require to be vistamatic type (horizontal blinds are not acceptable);

i) doors should have low-level viewing panels to ensure that a baby, toddler or young children or those in wheelchairs can see and be seen from either side of the door. Where a door has a single viewing panel, the minimum zone of visibility should be between 500 mm and 1500 mm from the floor. If a door requires an intermediate horizontal section for strength or to accommodate door furniture, the door should have two viewing panels, one accommodating a zone of visibility between 500 mm and 800 mm from the floor and the other accommodating a zone of visibility between 1150 mm and 1500 mm from the floor. Doors requiring vision panels are indicated in the ADB Room Data Sheets;

j) all doors to patient bedrooms, en-suites and bathrooms shall be fitted with a break-out (anti-barricade) facility which may be achieved by a combination of outward opening doors and ironmongery solutions. The Contractor will be expected to comply with anti-ligature/anti-barricade requirements in the Children's DCFP;

k) fire doors fitted with door closers are heavy and awkward to open and hamper easy circulation. All fire doors on circulation routes, and those not needing to be closed for security reasons, should be fitted with electromagnetic stays or swing-free door closers, which will close in the event of a fire alarm and be linked to the BMS to close at night. Door holds and door closers utilised in any location must not de-rate the fire rating of the door set to below that require for the location;

l) all bedroom doors which shall have free swing door closers (as HBN 00-04);

m) swipe card access and video plus audio door access will be required at the entrances to all departments, at links between departments to provide the necessary segregation, at all ward entrances, access points to staff only areas and access to FM/back of house areas;

n) all interview and consulting room doors to have a suitable level of acoustic performance to achieve the dB rating required by the ADB Room Data Sheets. Also refer to Section 7.8 – Acoustics. No air transfer grilles shall be permitted in these particular rooms and must comply with all requirements of the ADB Room Data Sheets;

o) the requirements for Radiofrequency shielding to doors within Radiology department shall be based on the requirements of the MRI scanner supplied and the siting of the device within the room and wider environment. Door leafs will typically incorporate copper or aluminium sheet materials and special details such as compressible brass finger strips at the head, sill and door jambs to maintain the continuity of the Rf cage electrical conductive construction. For the avoidance of doubt however it is required that the Contractor must seek advice from and agreement with the Board and the Board's Radiation Protection Adviser in this matter;

p) door closers to shielded doors require to be agreed with the Board and the Board's Radiation Protection Adviser;

q) all Radiology, Imaging and Nuclear Medicine x-ray rooms require lead lined doors as do all Theatres, dental (Children's hospital) and areas of A&E. The requirements for radiation protection shall be based on the designation and nature of the area, size of the room,

location of the door in relation to equipment and other risk factors. For the avoidance of doubt it is required that the Contractor must seek advice from and agreement with the Board and the Board's Radiation Protection Adviser in this matter;

r) doors must be fire resistant in line with fire regulations but, where connected to the fire and security alarm systems, must fail closed. Any alarm system linked to doors must not be compromised by even a short term power loss or surge;

s) doors to Theatres and Recovery areas require to open automatically upon activation of a push pad (not switch). Push pads to be sited to the left and right of both approaches to the door (i.e. 4 pads per door set). It should be possible to stand automatic doors in the opening position;

t) signs on or adjacent to all doors should be at a height of 800–1500 mm and tactile so that they can be easily read by touch;

u) external doors to non-public access areas should be metal-faced, solid timber core construction, other than louvred doors to plant areas, where ventilation is required;

v) any locked fire exit doors must have the capability of release on the activation of the fire alarm, or a local release facility of a type not likely to tempt patients to misuse it in line with Building Control requirements;

w) in the Children's Hospital doors to rooms that should not be entered by young children must be fitted with high-level latches. Where rooms require privacy, the doors should be fitted with 'free-to-escape' emergency release. In this case thumb-turn locks are not appropriate as young children can easily tamper with them, which could then cause panic in an emergency;

x) all external main entrances require to fitted with automatic sliding doors which protect both ends of a draught lobby. The entrance, doors and draft lobby must be designed to ensure that all normal hospital traffic can safely enter the building without compromising the inner environment (temperature and cleanliness, etc) or security of the building, throughout all weather conditions all in full compliance with HBN 00-04. For the avoidance of doubt all main entrances should allow for bed access/egress with a minimum clear width of 1740mm and doors should open automatically in the event of fire or power failure in line with the requirements of the Technical Standards requirements;

y) all fixings to ironmongery, fixtures and fittings in the Children's Hospital must be either securely concealed or be of a tamper-proof form (e.g. non-return screws);

z) the Contractor shall provide ironmongery which shall compliment the overall quality of the interior design concept. The Contractor shall ensure ironmongery is of robust construction suitable for its specific purpose and usage characteristics and in accordance with the Room Data Sheets. For ease of use by elderly or disabled persons the Contractor shall ensure handles are colour contrasted with the door background colour and of easy grip design. For ironmongery requirements refer to Section 7.11.1 Ironmongery;

aa) in 'back of house' areas such as catering, mortuary and all FM areas doors should be wide enough for trolleys and equipment to pass through easily and will need additional protection at heights related to equipment likely to cause damage. Any external doors to catering areas will require to be pest and insect-proof. All doors in food handling areas should have vision panels. Some doors may require security devices to allow access for designated staff only. For economy of space, chilled food stores and cold rooms may be fitted with sliding doors; flush thresholds are required to facilitate the passage of trolleys. Automatic cold air curtains should be fitted to maintain the temperature when the door of chilled food stores and cold rooms is open;

bb) Consideration should be given to providing doors within the children's hospital of different shaped vision panels, ironmongery and colours to provide a less clinical feel; and

cc) all doors within circulation and communication routes require to provide as large as practicable an effective clear opening width to allow the free movement of all forms of traffic. For the avoidance of doubt, the effective clear opening width for a swing door is the available width measured at 90degrees to the plan of the doorway clear of all obstructions (such as protruding ironmongery) when the door is opened through 90degrees or more. In all main circulation and communication routes (corridors over 1800mm) doors should comprise door leafs which are floor to ceiling heights with no overpanels. At these locations any door nib should be of a transparent nature in order to provide for maximum visibility to the corridor beyond.

7.5.6 Additionally, the Contractor requires to comply with the following:-

a) ensure that door edges do not present a hazard to visually impaired people when in hold open position. Contrasting texture flooring should be considered to guide people into the line of doors, as an integral part of the way-finding strategy;

b) light pressure delay check door closers should be provided to self-closing doors;

c) colour contrasted easy grip lever furniture and ironmongery;

d) any fully glazed doors or associated screens to have additional visual identification, for example applied manifestations;

e) level access to all doors, including escape doors;

f) generally, intermediate doors across main circulation routes should be held open on electro-magnetic devices linked to the fire and security alarm systems and designed to fail closed in an emergency or power failure.

7.5.7 Door Security

7.5.7.1 Door security requirements shall be identified in the relevant ADB Room Data Sheet, however the following criteria will require to be met by the Contractor;

a) access doors to patient areas will require to be alarmed and linked to a suitable alarm system capable of being monitored by the duty room or ward manager. This is vital within the Children's Hospital where all entrance/exit doors will require door control systems to prevent unwarranted access/accidental egress. They must be controlled externally with close proximity cards and internally by a press-to-release switch at a high-level. They will also be operated from a communications base, coupled with an audio-speech facility between the entry door and the communications base for identification purposes. Door control systems must be capable of manual or automatic release on initiation of the fire alarm system;

b) security measures are also needed to control unauthorised access to all departments through the use of swipe card and video entry systems. It is recommended that access through the main entrance to all areas be controlled by use of an entry-phone or intercom system with CCTV, linked to the reception/clerical office and communications base. Programmable close proximity card or similar systems must be fitted to changing room doors and used broadly across all departments. Ideally the programmable system should grant different patterns of access to suit the needs and privileges of authorised staff and visitors. The security measures chosen should not inhibit emergency escape from the above areas or access by the staff at any time;

c) all doors must be master-keyed / carded, with allowance for a suitable quantity of sub-master suites to facilitate the security zoning arrangements within the building such that each department, ward and service area can be locked down separately and with a master key. All doors throughout the building to have the same lock to allow a single key to be used by all staff. Spare cylinder and key sets to be maintained by the Contractor to allow ease of replacement. Secure and 'staff only' areas are to be controlled by proximity card readers linked to electrical locking devices in the doors. The proximity cards are to be contained within the staff I.D. badges. Contractor to provide facility to enable alterations to cards. Twelve thousand cards and lanyards are required to be provided by the Contractor;

d) there will be a decontamination entrance leading from the ambulance bay into A&E, which can act as a decontamination "airlock" with internal drainage and integral showering facilities with a "dirty" end onto the ambulance entrance and a "clean" end into the department. This area should have piped oxygen and suction to be able to manage the rare situation of a contaminated patient requiring resuscitative measures. This area requires to have audio/intercom communication with the adjacent hospital area to allow communication between staff;

e) the A&E will have secure entry and exit points which can be locked if required. Electric swing doors will be configured to open automatically if approached by a patient trolley. All other access will be by proximity card access by staff members; and

f) the A&E will have facilities for the management of high security patients, access to the treatment area for patient transfers of this type to have a discrete external door, security rated and access controlled as agreed with the Board and Strathclyde Police.

7.5.8 Draft Lobbies

7.5.8.1 All main entrances will require a draft lobby, the enclosure to the lobby requires to be fully glazed to enable users to proceed safely and confidently.

7.5.8.2 The lobby area should have absorbent and dirt-retaining flooring, over a sufficiently large area, to minimise damp and dirt being taken into the hospital to further minimise the risk of slip accidents. Mats must be able to be uplifted and removed from matwells for cleaning. For details of these requirements refer to floor finishes section – Section 7.9.2. Further, draft lobbies require to have air curtains and consider further energy efficient design features.

7.5.8.3 The size and shape of the lobby should also:

a) allow the smooth flow of users into and out of the building;

b) allow for the fact that users may congregate there;

c) ensure that by the time the second doors are reached, the first are closed;

d) provide a “modifying” environment between the outside and inside of the hospital; and

e) if other facilities are provided within the draught lobby, such as seats and payphones, they should not obstruct the passage of users.

7.6 **Windows**

7.6.1 Bedroom windows shall be sized and positioned so that patients can view through the window from their bed while sitting up, from a seated position and when standing. In the Children’s Hospital windows must have a low-level sill, a maximum of 600 mm high, to enable small children to see outside from their bed or cot. Blinds, controlled from within the room, are required for all internal glazed screens and windows to ensure privacy and also give protection from glare and solar gain.

7.6.2 The Contractor shall ensure that appropriate solar glazing and/or solar shading is incorporated on windows on typically East, West and South facing elevations. The Board will expect the Contractor to implement solar glazing/shading strategies as part of the overall solar heat gain and ventilation strategies. Further to this the Contractor will require to clearly demonstrate compliance with the environmental/energy targets as defined in Appendix M.

7.6.3 Natural light shall be provided in public spaces and in occupied private and staff spaces within the Facilities as far as is practical. Natural and artificial light sources should be designed to avoid or minimise glare.

7.6.4 Where possible all windows shall be designed by the Contractor to be cleaned externally and internally from the inside, unless otherwise agreed by the Board. The Contractor shall ensure no portions of windows, either fixed or opening should come below the level of worktops or desks except in in-patient areas where bedrooms and day dining rooms cills may be lowered to facilitate better external views. Locking devices to enable the windows to be released for cleaning purposes shall be by key or other device such that they cannot be released by unauthorised persons.

7.6.5 The following criteria require to be incorporated in the Contractor's Proposals:-

a) windows must combine security with good natural light and ventilation;

b) window frames to be of a robust and secure construction;

c) provision of external window cleaning system to ward tower, podium and all other windows;

d) all windows (in a naturally ventilated building solution) to have robustly controlled, limited openings to a maximum of 100mm clear opening (as per ADB Room Data Sheets and SHPN 03) with a robust, secure method of restricting the extent of opening;

e) all windows (in a naturally ventilated building solution) should be capable of opening in order to meet the desire to naturally ventilate the building as far as is practicable. This is required to address seasonal changes, where external temperatures may dictate that it is not desirable to open windows to achieve ventilation. The opening operation of all windows also needs to balance the desire to open windows against compromise of the security of the building envelope. The Contractor must submit full details of the proposed trickle vent with their bid, consideration should also be given to the effects of opening windows at height in the tower;

f) there may also be reduced air flow within the building as, for security reasons, some windows may not open extensively. With this in mind, it is essential that the ventilation and temperature control systems are of a high standard. The use of passive methods is encouraged;

g) as part of any passive, natural ventilation scheme dependant on the opening of windows, The Contractor shall demonstrate through thermal simulation (IES, TAS or equivalent) the optimum window opening arrangement has been selected to optimise thermal comfort with due consideration to any restrictions on openings;

h) the Contractor shall consider use of integral blinds to windows as part of the overall external shading strategy for the building along with meeting the specific requirements of the room as indicated in the ADB Room Data Sheets. The use of Integral blinds is considered to be advantageous in the area of Infection Control offering a practical solution to a range of cleaning issues. The Contractor must demonstrate maintenance and replacement methodologies for any proposed integral blinds (to windows or screens) and include robust gear and switching/movement controls;

i) in the critical care department windows in the single bedroom should be sealed. This is essential to maintain mechanical cooling and positive/negative airflow;

j) in the critical care department integral window blinds must be installed that can provide 'black-out' which is essential for ultrasound examinations and other imaging procedures;

k) proposals for the external solar shading of the building should be considered in the context of the overall design and, only if necessary, should consideration be given to solar glazing to south elevations. No reliance on the fitting of internal blinds can be used when evaluating reduction in solar gains;

l) where any windows require external security shutters, these shall be electrically operated and fully concealed;

m) window ironmongery in the shall be anti-ligature in the Children's DCFP;

n) windows that open onto courtyards where children play may constitute a hazard. Raised planting, for example, beneath them can prevent children sustaining injuries while running. In areas where children and young adults will be present Centre-pivot windows are to be avoided. Windows should preferably be of the sash-type with restrictors;

o) In areas where children and young adults will be present child-resistant locks should be fitted to all windows;

p) cords on window blinds or curtains should be kept short and out of reach of young children;

q) in order to promote good observation and communication between staff and patients in single bedroom ward areas large internal glazed screens between bedrooms and corridors should be incorporated. This will enable staff to observe patients and equally importantly, patients to see staff. However, patients should have the means to obscure windows where required through the use of integral blinds to provide privacy when required;

r) it should be possible for cleaners to gain easy access to the inside and outside of windows. A cleaning and access strategy for all windows and curtain walling requires to be provided by the Contractor, with all necessary equipment and access included in the Contractor's Proposals;

s) selection of the type of glass is crucial for the effective control of security, and for thermal and solar glare control and should be selected in conjunction with the overall consideration of environmental modelling of the Works. Colour rendering – for diagnosis of patients should also be considered in the choice of glass type for windows and screens. The robustness of all glazing must be appropriate to the functionality, relative to safety and resistance to damage;

t) the Contractor shall ensure that all handles or control gear shall be placed at levels which enables them to be operated by staff without the use of loose poles, and which do not conflict with the location of the adjoining construction elements, including blinds and curtains. Where windows are placed over worktops or desks, or where the operation as described above is not achievable, mechanical or electrical means of opening shall be provided by the Contractor with controls located in a suitable position within the room concerned;

u) the Contractor will be expected to use toughened glass in all locations (windows, doors, balconies, balustrades etc) except areas which are vulnerable to vandals or intruders at ground floor locations. As toughened glass is inherently strong and when damaged breaks into small pieces this is deemed to be less dangerous in terms of falling shards of glass or risk to vulnerable patients at risk of self harm. Laminated glass at ground floor level only will provide greater security. Laminated glass when broken will remain in place with numerous cracks, but the fragments are held together and do not separate therefore no hole left in the window for an intruder to get in through for example; and

v) One way screens/viewing panels should be incorporated as identified in the ADB Room Data Sheets.

7.7 **Building Envelope**

Facade

7.7.1 The Board would confirm that a variety of building envelope solutions will be considered in response to the following diverse challenges;

a) Energy usage;

b) Environmental considerations i.e. Odour from the nearby sewage works;

c) Ventilation and overheating;

d) Infection Control;

e) Acoustics;

f) Natural Light;

g) Cleaning and maintenance; and

h) Solar Control strategy

7.7.2 The envelope solutions which will be considered as acceptable to the Board include:

a) a partially sealed air conditioned building working in tandem with natural ventilation;

b) mechanically ventilated building working in tandem with natural ventilation;

c) double skin facade solution.; and

d) a sealed building where a maximum temperature solution is provided.

7.7.3 The envelope solution(s) proposed by the Contractor will require to be fully developed and modelled clearly indicating compliance with the Board's stated Sustainability and Energy Targets. It is not envisaged that a fully air conditioned solution alone will be capable of meeting the stated targets, however if this option is proposed, as above, a the Contractor will require to provide to the satisfaction of the Board a fully developed and modelled solution clearly indicating compliance with the Board's stated Sustainability and Energy Targets.

7.7.4 The Contractor shall also ensure that the external envelope shall incorporate provisions for its cleaning and maintenance. The Contractor shall ensure that the external hard and soft landscaping around the buildings shall allow access for the appropriate cleaning system, whether by ladders, mobile platforms or cleaning cradles attached to the building structure. Appropriate provisions shall be incorporated by the Contractor to allow the safe use of ladders. The external skin of the building shall be designed by the Contractor to accommodate the point load access of ladders and operatives, where the cleaning and maintenance system uses this method.

7.7.5 The following criteria require to be incorporated in the Contractor's proposals:-

a) external finishes shall be durable and easily cleaned, with finishes which may be vulnerable to abuse / vandalism (including graffiti) to be avoided;

b) anti-climbing measures shall be carefully considered, specifically in relation to any external wall-fixed rainwater goods and solar shading;

c) protection / avoidance from vehicular impact at drop-off, delivery points and the like is required; and

d) external detailing to avoid;

i) nesting or perching sites for birds and other wildlife;

ii) Unsightly weather staining of facades; and

e) Method of cleaning and maintaining façade

7.7.6 The Contractor shall design the building envelope to prevent rainwater entry into the building structure and the internal accommodation. Where water penetrates cladding elements, as part of the functional design and construction techniques, the Contractor shall ensure it is controlled and drained externally.

7.7.7 The Contractor shall ensure that all building elements and retaining structures shall incorporate appropriate means to resist the passage of dampness, both into the building structure and fabric, and into the accommodation, including the resistance to any hydrostatic pressure. The Contractor shall ensure that all such construction shall be in accordance with the requirements of the Building (Scotland) Regulations 2004, BS 8102 and Code of Practice CP 102 for Protection of Structures against Water from the Ground.

7.7.8 The Contractor shall ensure that the buildings are constructed and the design is detailed to limit air infiltration to minimum levels to reduce energy consumption and improve internal environmental conditions.

7.7.9 Performance demonstration tests for all roof and wall elements shall be carried out by the Contractor in accordance with the following:

a) BS 5368, Part 2: 1986 (EN86) Resistance to Water Penetration;

b) BS 5368, Part 3: 1986 (EN77) Wind resistance; and

c) BS 5368, Part 4: 1986 (EN86) Test Report Format.

Roof

7.7.10 The roof construction shall be fully weatherproofed, designed for minimum maintenance and suitably braced and held down to resist the influence of gusting winds appropriate to their locations. All penetrations through the roof membrane or cladding shall be suitably sealed to prevent the ingress of water. The roof shall be laid to falls appropriate to the adopted membrane or cladding and shall include sufficient provision of guttering and down pipes to adequately discharge rainwater to the underground drainage regime.

7.7.11 As part of the Board's sustainability requirements a strategy for rainwater harvesting should be considered by the Contractor. Where rainwater harvesting is incorporated, full risk analysis shall be carried out and tabled for consideration, all actions shall be taken to mitigate risks to infection control requirements. Rainwater harvesting is likely to be restricted to use in areas of the FM, Energy and Laboratory buildings.

7.7.12 The Contractor shall also ensure that all roofs shall incorporate provisions for cleaning and maintenance. Appropriate provisions shall be incorporated by the Contractor to allow the safe use of ladders, guardrails, walkways, access solutions and fall protection solutions in line with all Health and Safety Guidelines to prevent fall from height. This is a fundamental aspect of the roof design and a clear strategy detailing access provision will require to be demonstrated by the Contractor as part of the overall roof design.

7.8 Acoustics

7.8.1 The Contractor shall endeavour to minimise and mask ambient noise sufficiently to preserve patient privacy, confidentiality and maintain a calming atmosphere in public and patient areas.

7.8.2 Audiology booths require to be provided to the necessary acoustic and other standards.

7.8.3 The specific requirements of the Board with regard to Acoustics are contained in Appendix S.

7.9 Finishes

General Finishes

7.9.1 All wall finishes and backgrounds shall be selected and installed in accordance with SHTMs and appropriate British and European Harmonised Standard Specifications, Codes of Practice and ADB Room Data Sheets.

7.9.2 Areas of the Facilities that are subject to potential damage from trolleys, vehicles, beds or other similar traffic shall have adequate protection to comply with as a minimum SHTM 69 and in line with the specific requirements of Section 7.16.

7.9.3 The detail design and finished quality standards of certain specific finishes will be subject to the construction of mock-ups during the design and construction stages. These will form the benchmark for quality control of Site operations.

7.9.4 The use of colour patterning, motifs and texture should be considered by the Contractor in appropriate areas throughout the buildings as an integral part of the wayfinding strategy.

7.9.5 The following criteria require to be incorporated in the Contractor's proposals for all areas:-

a) internal finishes shall be durable and easily cleaned;

b) internal wall surfaces shall be resistant to damage appropriate to the location. Certain areas will necessitate severe duty partitions in accordance with BS 5234 Part 2:1992 (or equivalent), with wall protection. Severe duty partitions will be required in major circulation and heavy industrial areas such as FM;

c) wall finishes must be in accordance with the relevant SHTMs, HTMs HBNs, Design Guides, the Scottish Building Standards, and ADB Room Data Sheets and should also be appropriate to the activity space that they serve, in terms of: imperviousness; hygiene; joints; smoothness; moisture resistance; resistance to cracking; and resistance to abrasion;

d) internal partitions finishes shall also be as required by the nature and use of the accommodation and shall incorporate radiation protection requirements, sound reduction, fire resistance, humidity, biological attack and duty as identified by relevant HBN, SHTMs and appropriate British and European Harmonised Standard Specifications, Codes of Practice and ADB Room Data Sheets and as identified elsewhere in this document;

e) all wall finishes in clinical areas in the Children's Hospital must be durable and able to withstand wet cleaning and the accidental impact of trolleys and heavy mobile equipment. Especially vulnerable points must have additional protection. Smooth paint surfaces are the easiest for cleaning, for example eggshell or vinyl silk emulsion;

f) all wall finishes in clinical areas in the Adult's Hospital should be durable and able to withstand wet cleaning and the accidental impact of trolleys and mobile equipment. Especially vulnerable points should have additional protection. Smooth paint surfaces are the easiest for cleaning – eggshell or vinyl silk emulsion. A matte finish is not acceptable;

g) as the use of ceramic wall tiles is not acceptable in terms of Infection Control, impervious wall cladding is required in shower areas and as splash backs in kitchens, toilets, cleaner rooms etc;

h) The infection control team must be consulted and involved with material specification and detailing;

i) columns should be located, insofar as is reasonably practical, to coincide with corridor walls in order to minimise intrusion into rooms or corridors. Columns or ducts must not protrude into corridors so that they reduce the required minimum width; and

j) external walls and internal partitions shall be provided with movement control joints, appropriate to their material, method of construction and anticipated movement. Where movement joints are required these are to be identified on the layout drawings, these will not be acceptable within rooms or in clinical areas.

7.9.6 Additional specific finishes requirements that must be met by the Contractor's Proposals are identified below;

a) all Radiology, Imaging and Nuclear Medicine x-ray rooms require lead lined partitions and doors as do all Theatres, dental (Children's hospital) and areas of A&E. The requirements for radiation protection shall be based on the designation and nature of the area, size of the room, location of the door in relation to equipment and other risk factors. For the avoidance of doubt it is required that the Contractor must seek advice from and agreement with the Board and the Board's Radiation Protection Adviser in this matter;

b) the requirements for radiofrequency shielding to walls and doors in the Radiology department shall be based on the requirements of the MRI scanner supplied and the siting of the device within the room and wider environment. Walls and door leafs will typically incorporate copper or aluminium sheet materials and special details. For the avoidance of doubt however it is required that the Contractor must seek advice from and agreement with the Board and the Board's Radiation Protection Adviser in this matter, however full floor to ceiling protection should be included in all patient treatment areas (as well as full protection to all doors leading to or from treatment areas) in Radiology, Imaging and Nuclear Medicine x-ray rooms as well as all Theatres, dental (Children's hospital) and areas of A&E;

c) all Theatres throughout the facility should have no reflective surfaces or bright door handles as laser surgery may be undertaken;

d) where interventional procedures are considered, or will be undertaken in any room within the Radiology Department, the room finishes should conform to operating theatre standards. Ceilings should be continuous and impermeable. The provision of specialist paint finishes for ceilings and walls is expected and will be identified on ADB Room Data Sheets;

e) in all cases in the Radiology Department, overlapped sealed joints should be used over architraves and skirtings. Floors should be finished with non-electrostatic vinyl sheeting in order to avoid electrostatic discharges that may affect the function of the MRI and associated equipment;

f) wall and ceiling finishes in operating theatres should be impervious, durable and able to withstand wet cleaning and the accidental impact of trolleys and heavy mobile equipment. Especially vulnerable points should have additional protection. Protection measures should be considered at the initial design stage to prevent the need for regular maintenance which

would require the unit to be closed for long periods. The provision of specialist paint finishes for ceilings and walls is expected;

g) in the mortuary the floor of the body handling and post mortem area must be very hardwearing, non-slip, and impervious to water and disinfectant. The floor should be self-draining towards gullies to allow for drainage after cleansing. Walls should be capable of withstanding regular washing or hosing down, and should meet the raised junction with the floor at a waterproof joint. Ceilings should be capable of withstanding frequent washing down; and

h) IPS solutions shall be required in all toilet areas and areas where wet/sink provision is required (e.g. utility rooms). The use of flexible hose connections is prohibited.

Flooring

7.9.7 The Contractor shall ensure all level and inclined flooring shall meet the following minimum slip resistance requirements:

a) "Rz surface micro-roughness of 20 µm*;* and

b) "Slip resistance pendulum value of 36 (when either dry or contaminated)

7.9.8 The choice of flooring for areas, which may foreseeably become wet or contaminated, needs careful consideration. An anti-slip floor may be an effective control in some areas, such as kitchens, bathrooms, WCs and shower rooms. The choice of flooring will be influenced by the likelihood of the floor becoming contaminated and other factors such as the use of, and levels of, pedestrian traffic in the area. Effective cleaning will be important in maintaining the performance of anti-slip floors, however, it is important to establish with suppliers and cleaning staff that anti-slip flooring can be cleaned to appropriate hygiene standards. In certain areas such as operating theatres, where hygiene is paramount, this is especially important.

7.9.9 The flooring is just one, albeit important element, in the slip potential model and in areas where contamination occurs only occasionally, it may be more appropriate to control the risk through enhanced cleaning and management regimes. Therefore the Contractor requires to comply with the following;

a) the Contractor will require to demonstrate that a Risk assessment has been carried out in accordance with SHTM guidance. This assessment will require to be conducted in conjunction with the Board since as noted above, cleaning and management issues are factors in the assessment;

b) the Contractor shall, in order to complete a thorough risk assessment, procure test results in the "installed" condition which are independently verified by the Health and Safety Laboratory, Buxton, Derbyshire or approved equivalent. The method of testing shall be performed using a pendulum-coefficient of friction instrument with "Four-S" rubber, in accordance with approved HSE test methodology. For the avoidance of doubt, the obligation to follow the pendulum-coefficient of friction methodology is a specific obligation and is derived from the HSE, which only recognises this type of test;

c) the Contractor shall also ensure adoption of similarly robust test methodology for other areas including stair treads and nosings;

d) the Contractor shall ensure that all entrances to the Facilities incorporate appropriate floor matting designed to remove contaminants including water, dirt and leaves from footwear, trolley wheels etc. Barrier matting is most effectively deployed in conjunction with other controls including effective or enclosed canopies and heating, in particular underfloor heating and ventilation or a water evaporation system such as a hot air curtain; and

e) the Contractor shall be identify a strategy proposal at each entrance for agreement by the Board. The matting must extend a minimum distance of 6 metres along the route of travel within the building in line with NHS Scotland Safety Action Notice SAN (SC)05/08. For the avoidance of doubt the Contractor shall comply with all of the recommendations provided in SHS Safety Action Notice SAN (SC)05/08;

7.9.10 The following criteria requires to be incorporated in the Contractor's proposals:-

a) floor finishes must be in accordance with the relevant SHTMs, HTMs, HBNs, Design Guides, and the Scottish Building Standards, and should be appropriate to the activity space they serve in terms of imperviousness; hygiene; joints; smoothness; anti-static; slip resistance; absorption of liquids; radius of ignition. Areas with special requirements such as Operating Theatres and ancillary accommodation require particular consideration;

b) care must be taken in the selection of the appropriate soft floor coverings, for the avoidance of doubt carpeting or soft flooring will not be acceptable in any clinical areas;

c) in all areas the floor material should be coved to form the skirting (minimum of 100mm) to avoid angles and corners where microbial colonisation can occur. All coving must have a proprietary cap strip to the upstand. This detail will allow easy cleaning of the floor finish. In areas where frequent wet cleaning methods are employed, the flooring material should be unaffected by germicidal cleaning solutions, the skirting material used should be integral with, and have properties similar to, the floor finish;

d) vinyl, linoleum or rubber are examples of slip-resistant flooring and should have welded joints. The flooring should be at least 2.5mm thick;

e) all joints between sheet floor finishes and between cove skirtings are to be hot seam welded with care taken particularly at doorways (all welded joints and set in coves, no open joints or sit on cove);

f) loose laid barrier matting is not permitted;

g) visually contrasting texture flooring surfaces should be utilised, wherever appropriate, as an integral part of the way-finding strategy;

h) zero profiles are required at external access points, including access routes to any garden/courtyard areas;

i) smooth vinyl/linoleum coverings shall not be permitted in areas susceptible to wetting and where it is not reasonably practicable to keep them dry such as all WC's , En-suites, Clean/Dirty Utility Rooms, Cleaners Rooms, Assisted Bathrooms , kitchens etc;

j) early cognisance should be taken in the positioning of construction joints in flooring bases to avoid seams in floor finishes in the centre of rooms or circulation areas, joints in these areas will not be acceptable;

k) continuous flooring to be provided as far as is reasonably practicable, with no patching and utilising welded joints and set-in coves;

l) where movement joints are required these are to be identified on the layout drawings and will not be acceptable within rooms or in clinical areas. Movement joints must by flush with the surrounding floor finish;

m) the continuity and integrity of surfaces is important in all areas and particularly in wet and more clinically sensitive locations. Surfaces should be easily cleaned and finished to avoid potential dirt trapping points;

n) in wet areas such as shower rooms with level access floors it is important to avoid tripping hazards such as floor gulley surrounds and lippings to contain water;

o) floor gulleys, gratings and associated finishes should be integrated within the overall floor build up in accordance with relevant manufacturer's recommendations and to achieve tight and continuous sealing to minimise potential for dirt traps;

p) vinyl, linoleum or rubber flooring is tolerant of small movements in the structural floor. The floor screed therefore should be perfectly smooth, crack-free and stable. Adhesives should be powerful enough to resist the formation of "waves" in the floor finish that can result when heavy equipment is moved;

q) sufficient time should be allowed for the adhesive to set prior to use. Thresholds at doorways between adjacent rooms require particular attention because they are points of stress in the floor finish;

r) in theatres with laminar flow ventilation, the floor area enclosed by the hood should be marked with lines or a contrasting coloured area of flooring;

s) in the mortuary area it is important that the floor covering is chosen can be effectively cleaned, maintained and, where necessary, repaired. Vinyl anti-slip floor is often difficult to keep clean (due to grit type surface) and its iron-based particles produce stains, particularly visible on light-coloured flooring. A slip resistant resin flooring will require to be provided;

t) sprung flooring is required in gym and other relevant areas; and

u) waterproof finishes are required in bunding to theatre plant rooms, energy centre plant rooms and other plant areas where resilience is required to prevent water damage to areas below.

7.10 Interior Design

7.10.1 The interior environment is fundamentally important in achieving a non-institutional and therapeutic environment. The Contractor should focus on creating the highest quality spatial environments, which respond to the Boards ethos and operational needs. The interior design should be developed in conjunction with the master plan and architectural solution, producing a fully coordinated and complimentary scheme.

7.10.2 The aim should be to create progressive environments which respond sympathetically to their setting, whilst creating the opportunity to develop contemporary methods of working practices, including the development of large scale dynamic public spaces. The design should respond to client and user needs, whilst emphasising quality of materials, light and space.

7.10.3 The Contractor should seek to exploit the sensory elements of design to provide both information and stimulus. It is a physiological fact that the majority of information that we receive is visual. For sighted people, promoting the sensory aspects of design adds depth and meaning to the environment whereas for visually impaired people whose ability to access significant amounts of information is substantially limited, this design approach is fundamental to understanding the environment and operating independently within it. Because most visually impaired people have some sight, the use of colour to create contrast between critical surfaces and key design features is perhaps the most powerful way of accurately describing the immediate environment.

7.10.4 The use of tactile information should also be clearly developed in the Contractors approach, to all lift signage and door signage. Audible information, including the range of sounds created by contact with different surfaces can be extremely useful and the senses of both sound and touch affect the aesthetic experience of the environment.

7.10.5 The Contractor should demonstrate colour differentiation in surfaces. Visually impaired people are generally less confident at differentiating colours that fully sighted people, but if the colour difference is above a certain threshold value their confidence improves significantly.

7.10.6 The Contractor should indicate an understanding of the principle that the nature of the light source can significantly affect the way we perceive colour contrasts that are applied to the critical surfaces of an interior. Ceilings, walls, doors and floors are all critical surfaces that should be sufficiently differentiated from each other. Navigation through a building is much easier if these large areas re differentiated sufficiently by colour or material.

7.10.7 The Works shall contain a mixture of public, semi-public, and restricted areas which should be designed and articulated to create a hierarchy of spaces, clearly identified and linked.

7.10.8 In addition to the general and special considerations consistent with good Healthcare design, designers and planners will need to recognise:

a) the need to combine the individual specialist requirements for the care of patients with an environment that is a good for staff and welcoming to visitors;

b) The Board's requirement for the Works to meet high standards of quality, efficiency, and cleanliness;

c) the requirements of the staff for an attractive and pleasant environment to work in; and

d) The Board's requirements to ensure designs recognise environmental and ecological issues;

e) For reasons of infection control soft furnishings must be covered in an impervious material within all clinical and associated areas;

f) The interior design represents a challenging opportunity to provide an interior environment appropriate for a friendly and important public building of this type; and

g) To develop this to an agreed solution it is anticipated that extensive consultation will take place with user groups to ensure that the final outcome is projected to be responsive to the specific requirements of each element of the building;

7.10.9 It is important that the interior environment should be welcoming, comfortable, and enjoyable for patients, thereby limiting the institutional atmosphere typical of many healthcare Facilities. Users should be provided with external views and views to landscaped courtyards, corridors with break out spaces providing glimpses out of the building should also be incorporated to give users orientation.

7.10.10 The scale and diversity of patient facilities to be provided means that it will be extremely important to create individual identities to key areas within the overall building design. This will not only help patients identify and orientate themselves within the facility but will also help foster a sense of ownership among staff and a community spirit within individual elements of the building. A distinct identity should be immediately apparent in the Children's Hospital which will require through the use of colour, shape and motifs to provide interest and distraction for patients, parents and visitors alike. This will require to be reflected in all aspects of the design including flooring, wall finish, doors and ceilings. The importance of play for children, and the unique role of the hospital play specialist are described in 'Friendly healthcare environments for children and young people' (NHS Estates, 2003, pp 37–38).

7.10.11 Play specialists should be included when designing the New Children's Hospital as spaces for play are an essential requirement in all patient areas and present a unique opportunity for designers to provide creative and stimulating environments for young patients. This and the use of varied colours, murals, cartoons, varied flooring and the like are of extreme importance in the design of the children's areas and will be an important aspect for bid return and consideration.

7.10.12 The use of colour will help to differentiate the separate functions which share a common structure, and the use of symbols, graphic devices, furnishings, fabrics and accessories when thoughtfully co-ordinated will provide comfortable, yet clearly identifiable, internal environments for patients and staff alike. Any approach to this area of design must be developed carefully within the exacting requirements of procurement and to ensure an easily maintained solution.

7.10.13 It is possible that the Board shall invite external patient support groups and family groups to assist in interior design solutions and activities. The Contractor shall require being aware of such, and engaging with such groups during design development and construction. Such groups shall have an ongoing role within the Works and shall be desirous of incorporating exhibitions and artwork/contributions in the Works. The Contractor shall require supporting such an interface and allowing works to be displayed on wall finishes and the like. The Contractor's Proposals shall reflect such interfacing and engagement.

7.10.14 The Contractor shall develop an interior design strategy to cover all areas of the Works. The interior design proposals shall promote the ideals of the Identikit guidelines.

7.10.15 Proposals shall be presented by the Contractor in room-by-room schedules with samples of finishes, colours, lighting fittings, materials as appropriate, and signage, supplemented by colour sketches or coloured computer images for agreement with the Board, in time to allow for consultation with the users, and for incorporating feedback into the final scheme.

7.10.16 It is expected that the Contractor will provide Interior 3D perspectives and an Interior Colour Strategy Report detailing the following – this is not an exhaustive list;

a) Internal Views of Atriums, entrances and key high profile public areas;

b) Views of Hospital street/Mall including retail area;

c) View of receptions and waiting areas;

d) Ward areas and bedrooms; and

e) Theatres.

7.10.17 The above information should indicate the following information;

a) Architectural vision – space, height, form, composition, scale, character and use of materials;

b) Finish type, colour;

c) Overall colour strategy;

d) Incorporation of Art; and

e) Wayfinding Strategy including images

7.10.18 Where the Contractor includes internal planting displays, associated irrigation and atmospheric controls shall be provided. The Contractor shall ensure that the building design and services allows for an appropriate level of light to ensure the growth and survival or any interior planting within their design.

7.11 Architectural Hardware

Ironmongery.

7.11.1 The following criteria require to be incorporated in Contractor's proposals:-

a) the locking system shall be fully suited across the Works and shall interface with swipe card / other entry systems where provided. Particular requirements with respect to electronic door access / security requirements are contained in Section 8.3.14;

b) ironmongery, fixtures and fittings in the Children's DCPF shall be anti-ligature and anti-barricade;

c) all fixings to ironmongery, fixtures and fittings (in patient areas) must be either securely concealed or be of a tamper-proof form (e.g. non-return screws);

d) where indicated in the ADB Room Data Sheets mirrors to be shatterproof glass, with concealed fixings;

e) all joints between flush fitting components and adjoining surfaces to be as tight as practicable; and

f) all fire fighting equipment to be located within secure lockable containers housed in the wall construction, and operated by the same key throughout the development (all fire fighting equipment to be supplied by the Contractor);

g) in the interest of children's safety door handles to the kitchens should be located at a high level to prevent unauthorised access;

h) the Contractor shall provide ironmongery which shall compliment the overall quality of the interior design concept;

i) the Contractor shall ensure ironmongery is of robust construction suitable for its specific purpose and usage characteristics and in accordance with the ADB Room Data Sheets. For ease of use by elderly or disabled persons the Contractor shall ensure handles are colour contrasted with the door background colour and of easy grip design; and

j) samples of all the ironmongery products shall be prepared in accordance with section 5.9. Details of lock suiting will be submitted by the Contractor to the Board to allow adequate time for discussion and amendment if necessary before the fittings are required for installation in the buildings.

Blinds & Curtains

7.11.2 The following criteria will require to be incorporated in the Contractor's proposals;-

a) the Contractor shall provide all fixings for blinds and curtains including integral blinds;

b) all blinds, curtains and associated fixings shall be Class 0 rated;

c) the Contractor shall ensure that materials for blinds and curtains (including any cubicle curtains) shall also comply with the requirements of the Board's Control of Infection Officer for cleaning, washing and maintenance, and comply with SHFN 30 and SHTM 87, and specific Safety Action Notes. For reasons of infection control curtains must be able to withstand washing processes at disinfection temperatures;

d) the Contractor shall provide integral blinds to windows, curtain walling and internal screens;

e) The locations and fixings for both blinds and curtain tracks and cubicle curtains shall be co-ordinated by the Contractor with the window and internal window sill design from the outset of the building design development and the fixings shall be designed by the Contractor to take the proposed maximum loadings possible for the tracks concerned and shall be non-weight bearing from an anti-ligature perspective in the Children's DCFP. For the avoidance of doubt all curtains, blinds, accessories including fixings are to be provided by the Contractor;

f) Curtain tracks shall be designed by the Contractor to overlap the window openings so that they do not allow light to pass into the room when drawn. Controls for blinds and curtains shall be co-ordinated by the Contractor with the window design and its opening gear, including any operating handles, levers or stays that may be required and shall be located conveniently for staff or patients to operate as appropriate;

g) The Contractor shall fix bed and cubicle curtain tracks at the height recommended in the relevant guidance and The Contractor shall ensure bed curtain tracks are co-ordinated with other service outlets and the window positions, where applicable. An adequate ventilation gap must be provided by the Contractor at the curtain head; and

h) All Single bedrooms should have glass partitions for observation purposes, complete with integral venetian blinds for privacy.

7.12 Staircases, Ramps, Balustrades, Walkways, Escalators & Lifts

Staircases and Ramps

7.12.1 Where staircases, ramps, balustrades, walkways and lifts are provided in addition to those required to satisfy means of escape criteria, these shall be designed to relate to the anticipated capacity of use and clearly designated for public, staff or service circulation.

7.12.2 For the avoidance of doubt, the Contractor requires to ensure that for all stairs the requirements of HBN 00-04 and Technical Standards are achieved. This includes the following key criteria;

a) the maximum number of risers between landings for a flight of internal stairs should be 12-14;

b) risers and goings uniform, riser height should be 150-170mm, going minimum of 280mm, 300mm preferred;

c) for steps not adjacent to a wall, a barrier, with a minimum height of 100mm above the level of the treads should be provided for safety reasons. This requirement should be developed in conjunction with the design of the stair / balustrade to viewed as a cohesive whole;

d) open areas on the underside of stairs should be avoided to eliminate the possibility of anyone walking into the overhang created;

e) to indicate that there are descending steps ahead, a hazard-warning zone should be provided on each landing. The zone should use a floor finish that contrasts visually with the general floor finish, but has the same slip resistance. The warning zone should be at least 400 mm from the nosing and a minimum of 800 mm deep and 1200 mm wide;

f) capable of achieving mattress evacuation; and

g) where ramps are provided in addition to those required to satisfy means of escape criteria these shall be suitable for independent and / or assisted wheelchair users, trolleys and ambulant disabled people. Ramps, however will not be considered appropriate for any significant changes in level.

7.12.3 The atrium will contain link bridges, escalators, lifts and stairs providing all vertical and horizontal communication links across the void space providing the necessary connections between departments. A high level of finish will be expected for all stairs and balustrades, any handrail, barrier or guarding to stairs or corridor links should be glazed to allow views for children and those in wheelchairs.

Lifts and Escalators

7.12.4 For the avoidance of doubt, the Contractor requires to ensure that for all lifts the requirements of HBN 00-04 and HTM 2024 are achieved. This includes the following key criteria;

7.12.5 The number, type, size and speed of lifts should be determined from a traffic analysis specific to the proposed facility, and should allow adequate flexibility of the lift solution to accommodate future changes. However as a guide the following dimensional requirements will be achieved;

Lift Type	Minimum Sizes
All lifts	1100mm (wide) x 1400mm (deep)
Small General Traffic	1600mm (wide) x 1400mm (deep)
Large General Traffic	2000mm (wide) x 1400mm (deep)
Patient Trolley/Stretcher Movement	1400mm (wide) x 2400mm (deep)
Bed Movement Lifts	1800mm (wide) x 2700mm (deep)

7.12.6 Handrails should be provided on both side and rear walls of lift cars to be used for general traffic, this includes where stretcher/trolley lifts are to be used for general traffic. The minimum dimensions noted in the table above will require to be provided clear of handrails.

7.12.7 In order to segregate traffic, for operational and infection control reasons, it is not anticipated that lifts for bed movement will be used for general traffic.

7.12.8 Dedicated vertical lift facilities will be required as part of the installation of the overall Automated Material Transfer System as outlined in Appendix M. A clear strategy for the incorporation of these systems will require to be provided by the Contractor in consultation with the Board. The use of public and personnel lifts by automated systems is not acceptable.

7.12.9 Lift doors for general traffic should provide a clear opening width of 1100mm and height of 2000mm. Lift doors for movement of patient trolleys/stretchers and beds should provide a minimum clear opening width of 1370mm and a height of 2100mm.

7.12.10 Additionally the following criteria should be met:

a) the lifts within the atrium should be fully glazed to all sides providing views over the atrium space for the purposes of orientation;

b) a protected lobby should be provided where a lift does not open off a hospital street;

c) wall-wash lighting, uplighting or perimeter lighting should be utilised in the lift car rather than direct downlighting to avoid dazzling patients being transported on beds, trolleys or stretchers;

d) a visually contrasting floor surface measuring at least 1500 x 1500mm should be provided outside the lift door area;

e) lifts, where provided, are to be suitable for disabled wheelchair persons and visually impaired, with tactile controls and audible warnings; and

f) the use of escalators within the atrium space to access the upper level of Outpatients department is considered as desirable. All aspects of the Escalator design should be designed to the requirements of BS EN 115-1:2008.

7.13 Landscape Design

General Design Approach & Aspiration

7.13.1 In accordance with the principles of 'Designing Places – A Policy Statement for Scotland' (Scottish Executive 2001) the site layout and landscape design shall create external spaces that are distinctive, safe and pleasant, easy to get to and move around, welcoming, adaptable and resource efficient.

Existing Site

7.13.2 The existing hospital campus generally presents a poor quality environment for visitors, patients and staff.

7.13.3 It is dominated by large expanses of blacktop roadway and vehicles, disparate and scattered buildings, open yards, service bays and large flat areas of featureless and exposed open space. The site does include a number of mature trees which are subject to a Tree Preservation Order (TPO). The majority of these are to the eastern side of the campus, visible from the approach to the Clyde Tunnel, away from the principal area of the proposed new hospital development. The few mature trees remaining on the proposed site of the new hospital will need to be removed to facilitate the required building footprint and infrastructure.

Landscape Masterplan

7.13.4 The masterplan prepared for the development of the Southern General Hospital seeks to address many of the negative landscape issues currently affecting the campus and to provide the framework for the development of a high quality, coherent, well organised and welcoming external environment to enhance the experience of staff and patients alike. This includes the provision of a major new access from Govan Road together with a significant rationalisation of internal roads and paths to provide clear and direct approaches to the proposed new hospital and improved links throughout the campus with its hinterland. The proposed layout attempts to integrate private vehicular access, public transport and the new Fastlink route with pedestrian and cycle circulation to provide a vibrant but coherent new public realm within the heart of the Campus. In particular, the masterplan sets out the framework for the creation of high quality public realm and street frontages to the entrances associated with the proposed hospital within a strong landscape framework of formal avenue and informal tree planting. This is essential to create both a high quality setting and to provide the human scale necessary to offset any negative influence from the visual dominance of the size and physical mass of the building envisaged.

7.13.5 In particular the masterplan creates a large, central open space within the heart of the campus to be developed as a park for the use of patients, visitors and staff alike. This is intended as a multi functional space providing for social interaction and relaxation as well as opportunities for informal exercise with marked walking routes and a trim trail. The Contractor is to also to include works of art and sculptures in this area.

Hard Landscape - General

7.13.6 Areas of landscape and public realm shall demonstrate a high quality of detailed design, utilising high hard quality sustainable and durable materials to achieve design life noted in Section 5.3 The choice of materials shall reflect both the quality and importance of the proposed new building as well as the aspirations in the masterplan to create, a people friendly external environment. The contractor's attention is drawn to the need to ensure long term sustainability and the requirement to achieve the BREEAM Healthcare "excellent" rating. In this regard due reference shall be paid to the BRE "Green Guide to Specification" to maximise the use of materials and specifications achieving an A rating or better as far as is practicable with regard to other technical and specification requirements in terms of adoption and compliance with standards and legislation noted elsewhere.

7.13.7 The masterplan envisages a hierarchy of spaces and circulation and consequently surface treatments and materials shall vary accordingly.

7.13.8 The minimum standard for a pedestrian footpath within the site shall be asphalt with pre-cast concrete flat-top pin kerb edges to GCC Roads Department adoptable standards as identified in Section 9.0. At the top end of the hierarchy in the spaces associated with the frontage of the building and the main entrances, high quality modular or unit paving shall be used that shall feature clean, crisp detailing and edging together with striking and vibrant paving patterns and designs commensurate with the very best of 21st Century urban design.

7.13.9 The contractor will be expected to demonstrate a clear gradation of hierarchy within their design and choice of materials, between these two in terms of intermediate public spaces and major footpath routes around the site and within the new public park.

7.13.10 Design of all hard landscape in terms of accessibility, surfaces and gradients shall conform to or exceed BS8300 as well as to maximise long-term sustainability and BREEAM Healthcare scores.

7.13.11 Hard landscape materials, specification and laying shall conform to the following minimum standards, where relevant.

a) BS 7533 (all relevant sections pertaining to the materials chosen);

b) BS EN 1342 (Setts of Natural Stone – Requirements and Test Methods);

c) BS EN 1341 (Natural Stone – Requirements and Test Methods); and

d) BS EN 1339 (Concrete flags – Requirements and Test Methods).

7.13.12 Maintenance of hard landscape areas shall be in accordance with BS 7370 – 2. The contractor shall develop and submit a fully detailed maintenance schedule for all areas of hard landscape and associated street furniture and play equipment.

7.13.13 New access roads and vehicular circulation routes shall be designed and constructed in accordance with current highway design standards and to Glasgow City Council Roads Department, adoptable standards to the extent identified in Section 9.0. This to include all road markings to all roads, cyclepaths and car parks (incl car parking bays/spaces and drop-off points, ambulance areas and the like) and all road signage. Raised kerbs to bus drop-off/stops to be included.

7.13.14 The detailed design of vehicular roads shall incorporate appropriate traffic calming and speed control measures to reduce vehicle speeds and contribute to a pedestrian friendly environment. Consideration requires to be given to the transport of patients (particularly spinal patients) in the design of traffic calming methods. Along the hospital frontage at drop-off points and where large numbers of patients and visitors will be expected to congregate and enter the building, a change in surface material for the carriageway shall be utilised that provides the appropriate visual signals for both pedestrians and vehicle users alike and is commensurate with the high quality paving design and external environment required for the building frontages.

7.13.15 Pedestrian crossing points shall be provided at frequent intervals as indicated on the masterplan. These shall be formed at footpath rather than at road level in order to both achieve BREEAM points as well as to provide a traffic calming measure.

7.13.16 Roundabouts and important junctions shall be landscaped distinctively to provide a clear visual orientation point within the site and to reduce the apparent expanse of road and hard standing in these areas. Where possible public art or sculpture shall be incorporated in the roundabout designs to reinforce their distinctiveness.

Cycle Access

7.13.17 The design shall include improvements and modifications to the existing cycle access points, as well as creating new cycle access at appropriate locations to the site as indicated on the masterplan. New or modified cycle access shall be off-road and shared with pedestrian traffic as far as possible. In this regard, cycle paths shall be a minimum of 3 metres wide in order to comply with current guidance from Sustrans and to gain BREEAM Healthcare points. Where cycle lanes are provided either as separate routes or on roadways, the minimum dimensions and layout shall be in accordance with the above noted guidance and to the minimum required in BREEAM Healthcare.

Cycle Shelters

7.13.18 Cycle shelters shall be provided in the numbers required to achieve BREEAM Healthcare points. Cycle shelters shall provide secure and sheltered space for the parking of bicycles and shall be in a secure and visible location. Cycle storage areas shall be located adjacent to or as near as possible to building entrances to ensure direct safe and easy access/egress. Cycle shelter areas and their approach paths shall be lit to adoptable street lighting standards and shall be capable of being overseen by CCTV both day and night. Consideration of cycle stacking systems should be pursued by bidders and proposed to the Board.

Courtyards

7.13.19 The design of the new hospital building envisages the creation of a number of external courtyards for use by staff, visitors and patients. The courtyards shall be designed to provide a variety of purposes including opportunities for meeting and social interaction as well as quiet reflection and privacy. Where appropriate, courtyards and external spaces within the building shall have a practical and or therapeutic purpose, for example the incorporation of steps and ramps to assist with physiotherapy, as well as simply providing a view of plants, green space and natural light within the interior of the building.

7.13.20 In order to comply with BS8300 and the principle of free access, the finished paving level at building entrances shall be the same as the adjacent internal floor level. The building design in this location shall utilise a raised, DPC detail in order to ensure finished levels within the courtyards are visually unobtrusive. A solution which creates a series of humps or rises and falls between doorways opening out into courtyard areas will not be acceptable.

7.13.21 The internal layout design of the courtyard shall allow for any requirements for maintenance access to the building edges.

7.13.22 The courtyard paving shall be formed from high quality modular and unit paving with detailing commensurate with scale of courtyard in question. Path widths and circulation spaces shall be in accordance with minimum standards set out in BS8300 and BREEAM Healthcare, whichever is the greater. Courtyards shall include high quality planting design that incorporates the opportunity to introduce a variety of domestic/garden scale plant material including a mixture of evergreen, deciduous and herbaceous material together with bulb planting. The extent and type of plant material shall reflect the nature and function of the courtyard in question. Courtyards shall include a variety of seating opportunities to ensure that there is provision for both quiet and private contemplation and social interaction for group discussion. All courtyards shall be provided with litter bins and low level external lighting. Seating shall be in a variety of forms but as a minimum at least half the seating provided shall include backrests and arm supports. The design of the courtyards shall not restrict seating opportunities to purpose made bench or seat provision only and seating opportunities and areas of social interaction shall be incorporated into the overall courtyard design, utilising a variety of means including low walls and edgings at seat height.

7.13.23 The courtyard design shall include wherever possible the provision of tree planting in order to provide some height and to offset the potentially oppressive effect of the courtyards being surrounded by tall walls on four sides. The courtyard designs shall also incorporate some undulations and changes in level and provide visual relief from the prospect of a flat plain. In detail, courtyard designs will be expected to provide both open and intimate enclosed spaces within their overall layout.

7.13.24 The detailed design and specification of the courtyards shall provide a variety of visually distinct spaces in order that they can contribute to the wayfinding strategy and orientation round the building for patients, visitors and staff.

7.13.25 Notwithstanding the above requirements, courtyard design shall provide low maintenance external space.

Children's Play Areas and Play Equipment

7.13.26 The masterplan envisages the creation of a children's play area adjacent to the main entrance to the Children's Hospital. The purpose of this provision is both to provide a relaxed and welcoming child friendly entrance whilst at the same time actively making safe provision for children's play, whether children are outpatients or visitors to the hospital.

7.13.27 All children's play equipment shall conform to the relevant parts of BS EN 1176 and be expected to provide a design life with regular maintenance of 25 years. The contractor shall offer a range of equipment that provides the best manufacturer's warranty available and for which the supply of spare parts in guaranteed for the anticipated design life of the equipment.

7.13.28 All play equipment shall be installed with an appropriate safety impact absorbing surface suitable for the equipment in question. All safety surfacing shall be of a 'wet pour' or other continuous type surfacing system rather than tiles or loose-fill materials such as bark or sand. The final choice shall be influenced by the materials' longevity and lifecycle costs.

7.13.29 Play areas shall include a mix of equipment suitable for a broad range of ages and abilities appropriate to the context of the Children's Hospital (from toddlers through to young teenagers) and include a degree of open or free space. Seating opportunities for casual supervision by parents and carers shall be maximised and include a sufficient quantity of litter bins. Seating may be varied but must include at least 50% with back support. Provision of equipment for young children and toddlers shall include coloured boundary fencing with non-slam self closing gates.

7.13.30 The provision of an area of the play zone to be under the neo-natal link, thereby providing for an outdoor visit or play space usable in wet or inclement weather, is to be developed by the Contractor and included in the design.

Street Furniture - General

7.13.31 Street furniture shall be robust, practical and fit for purpose whilst at the same time being of a contemporary high quality design. The specification of different materials shall pay regard to both cost and long term sustainability. Any timber utilised shall be from a sustainable source and be FSC Certified Timber, where it is not of the type that is inheritantly long lasting in external or wet conditions shall be preserved, treated with a minimum 15 year lifetime guarantee or better. Street furniture items shall form a key component of the external landscape design, especially in the public realm, at entrance areas surrounding the building and within the parkland. The contractor shall provide a well considered and coherent design that presents a suite of complimentary elements that are integrated into the overall public realm and landscape design. All mild steel components and fittings shall be galvanised to and polyester powder coated or otherwise factory painted and supplied with a minimum warranty of 15 years or better prior to any retouching or painting being required.

7.13.32 All street/external furniture requires to be securely fixed to the ground.

7.13.33 Bus stops and shelters require to be installed as necessary to comply with the relevant Planning and Travel Plan requirements;

7.13.34 Covered architectural pedestrian walkways are to be provided between the Fastlink drop off area and the adjacent entrance to the new hospital as illustrated on the masterplan drawings;

Litter Bins

7.13.35 All litter bins shall be of the type which includes a front facing door or hatch that allows the internal bin or receptacle to be removed and emptied easily

Seating

7.13.36 It is anticipated that a wide variety of seating and seating opportunities shall be incorporated into the final design. The majority of this will be purpose made seating or seat items however the contractor is also expected to incorporate into the design opportunities for seating within the landscape in the form of low walls, steps and grass mounds.

7.13.37 Where formal seating is provided at least 50% of this shall include backrests and armrests. Seating shall be designed and located as a key element of the overall landscape design. Seating and benches placed seemingly at random will not be acceptable. The contractor shall ensure that adequate seating and rest points are provided at regular intervals along pathways and walking routes.

7.13.38 All seating must be securely fixed to the ground.

7.14 Soft Landscaping Requirements

General Design Approach

7.14.1 In accordance with the principles of 'Designing Places – A Policy Statement for Scotland' (Scottish Executive 2001) the planting and soft landscape design shall contribute towards the creation of external spaces that are distinctive, safe and pleasant, easy to get to and move around, welcoming, adaptable and resource efficient.

7.14.2 The landscape of the existing campus is largely flat, featureless and unwelcoming. In accordance with the masterplan the new planting design shall include substantial tree planting to:

a) provide immediate and long term landscape structure and impact within the campus grounds;

b) create a distinctive and appropriate landscape setting for the new hospital complex;

c) mitigate against the visual impact of the buildings, roads, car parking and hardstanding across the site and provide human scale; and

d) mark progression along key routes and lend identity to the different spaces that will be created.

It is required that semi mature and larger nursery stock trees are utilised along principal avenues, paths and thoroughfares to achieve this requirement.

7.14.3 The detail planting design and specification shall provide an appropriate mixture of seasonal variety, height and colour for all year round interest. It shall provide both immediate impact and medium to long term growth and be capable of delivering a high quality landscape that will develop and mature over the medium to long term. The detail design layout and choice of plant material shall be appropriate to the immediate context, such as public realm, pathways and circulation zones, private/quiet space, spaces for adults, children, visitors and patients, whilst paying due regard to environmental and climate factors. The planting design shall help to provide shelter and shade as well as assisting users to orientate and locate themselves. The planting and landscape design should be developed to reinforce wayfinding strategies through the creation of readily identifiable and distinguishable spaces.

Retention & Protection of Existing Trees

7.14.4 As far as possible, the campus layout shall maximise the retention of existing mature trees on site and incorporate them into the overall layout and landscape design. In accordance with planning conditions and best practice, all trees to be retained in the medium to long term shall be protected in accordance with BS 5837:2005, the exact method to be agreed with the Planning Authority.

Felling of Existing Trees & Vegetation Clearance

7.14.5 In accordance with the Wildlife & Countryside Act 1981, any tree felling and shrub clearance shall be carried out outside the bird breeding season (March to August). Contractors shall take due cognisance of this requirement in any work programming. Where this is not possible a qualified ecologist shall be appointed to examine all potential breeding sites before any clearance takes

place. If occupied nests are found, clearance and felling works shall cease until the nest is no longer in use. The contractor shall formally confirm to the Planning Authority in writing if clearance is in order following the ecologist's inspection. A qualified Ecologist shall be as defined in BREEAM Healthcare.

7.14.6 Where any tree work is undertaken this shall conform to BS 3998 "Recommendations of Tree Works and current HSE/AFAG safety leaflets

CAA Restrictions

7.14.7 The site lies approximately 3 km from Glasgow Airport, well within it's 13km 'safeguard circle' and therefore detailed consultation with the CAA will be required to develop proposals that minimise any increased risk of birdstrike. The landscape and planting design shall form an integral part of the 'Bird Hazard Management Plan' which is required for submission to the Planning Authority. The Contractor shall comply with the CAA publications CAP 772 – 'Birdstrike Risk Management for Aerodromes' and Advice Note 3 – 'Potential Bird Hazards from Amenity Landscaping and Building Design'. It is likely that adherence to this guidance will impact on the specification of plant material and contractors are therefore required to consult early with the CAA to establish their requirements. Approval by the CAA of the detailed landscape proposals will be required to clear the Planning Conditions relating to the detailed landscape design.

Landscape Design and SUDs integration

7.14.8 Landscape design associated with SUDS shall comply with CAA Advice Note No.6 – 'Potential Bird Hazards from SUDS'. Any surface water features associated with a SUDS design for the site shall be fully integrated with the landscape design, as opposed to simply 'landscaped'.

7.14.9 The SUDS solution of the Contractor shall actively consider underground storage tanks which shall consider the use of the water for grey purposes on the site where possible.

Biodiversity

7.14.10 The detailed landscape and planting design shall be developed in accordance with the 'Biodiversity Action Plan' submitted to the Planning Authority as part of the Masterplan.

7.14.11 It is a Planning Requirement that the new landscape framework for the campus will link areas of established green networks within and beyond the site, SUDS proposals and movement networks (roads, footpaths and cycle paths) to habitat retention and creation, minimising the impact of the development on wildlife and vegetation. Contractors will require to reconcile the requirements of the Planning Authority with the restrictions that may be required by the CAA as noted above, together with maintenance regimes on site in the detailed landscape and planting design. Contractors will be required to undertake a detailed habitat assessment using a qualified ecologist to establish the baseline situation at the start of the contract to inform the detailed landscape design development.

BREEAM

7.14.12 The Contractor shall maximise BREEAM Healthcare points available through the landscape and external works as a key element of their designs. In conjunction with 'Biodiversity' above, a qualified ecologist will be required to undertake a habitat survey to establish the baseline situation at the start of the contract to inform the detailed landscape design development with a view to achieving maximum points available and contribute towards the required "excellent" rating.

Topsoil

7.14.13 Should topsoil stripped from the site be retained on site, this requires to be in a dedicated storage area, appropriately stored, protected from contamination, maintained and re-used within the final landscape works as required. The Contractor will be required to undertake a comprehensive soil analysis (BS 3882 Annex E) to determine whether there is any contamination present that would limit or otherwise restrict the use of site stripped topsoil within the final landscape works.

7.14.14 If it is determined that the material be taken off site, either on a temporary or permanent basis, this shall be agreed in writing with the Planning Authority in accordance with condition 9.

7.14.15 The soil analysis shall also determine nutrient deficiencies and the requirements for fertilizer and soil additives required to ensure the successful growth and establishment of the planting specified for the areas to which it is finally spread.

7.14.16 Imported topsoil shall be to BS3882 "multipurpose" grade or as required to suit the final choice of plant material. The use of peat shall not be permitted. All compost shall comply with PAS 100.

Topsoil Storage

7.14.17 Where imported or existing topsoil is to be stored in a single location for no more than 6 months (maximum) the height of storage mounds shall not exceed 2M. Where a period of more than 6 months is required the height of the mounds shall not exceed 1M high. Where existing topsoil is stripped and stored the soil shall be turned every 6-12 months.

7.14.18 All topsoil stored for longer than 6 months shall be re-tested to determine the degree of nutrients, fertilizer and ameliorants required immediately prior to re-spreading in its final location.

7.14.19 Topsoil depths for planting:

a) Shrub planted areas: 400mm minimum depth; and

b) Grass areas: 150 mm minimum depth;

i) General handling and contamination prevention; and

ii) Subsoil/ground preparation for landscape areas.

Plant Material

7.14.20 The specification criteria for plant material in general shall conform to either the National Plant Specification or BS 3936 and other related British Standards. The specification criteria for Semi Mature and Root-Balled Trees shall be to BS 4043.The handling, transportation, storage and establishment of plant material shall be in accordance with the Horticultural Trades Association publication 'Handling and Establishment of Landscape Plants'. Contractors will be responsible for developing a robust and technically competent specification for all the soft landscape and planting works in accordance with the best industry standards and practice.

7.14.21 The choice of plant species and provenance of plant material shall be appropriate to achieve the purpose required by the design and for the location, scale and situation in question. There is no general limitation on the type and range of plant material envisaged with the following exceptions:

a) Thorny or spiny plant material shall be avoided, especially within the body of the site within the ornamental species mixes. This type of material traps litter and debris which is then extremely difficult to clear and consequently encourages the nesting of vermin. Possible exceptions might include the use of Hawthorn or other native hedgerow plants along the site boundaries in association with structure or woodland planting, depending upon the final design layout.

b) Poisonous plants/skin irritants on contact with foliage/stems further definition required.

7.14.22 Planting densities and size at planting shall be appropriate to ensure a careful balance between immediate and short term impact and long term growth.

7.14.23 Tree planting pit/trench size and design shall be appropriate to ensure the long term establishment and future growth of all new trees. This shall include where required the use of drainage, irrigation tubes and root protection barriers adjacent to services. All semi mature trees shall be underground guyed using an approved proprietary product such as the Platipus system (or equivalent). All tree staking shall be double short stakes with cross bar.

7.14.24 All semi mature tree planting shall be provided with a 5 year establishment guarantee from the supplier(s) The defects period and contractors' liability for replacement planting shall extend to the full period of the guarantee, subject to standard industry limitations. The defect period for tree planting in general shall extend to a minimum of two growing seasons following agreed completion of the contract.

7.14.25 Extended establishment guarantees from suppliers shall be required in relation to semi-mature tree planting.

7.14.26 Any seeded areas are to be protected by secure temporary fencing (secure to the ground and securing the seeded areas from access) until such time as the seed takes.

7.14.27 Any grass adjacent to the children's play areas and entrance to the Children's Hospital to be turfed.

Maintenance

7.14.28 The contractor shall develop and submit a fully detailed management plan and maintenance schedule of the completed landscape design for approval. Maintenance shall generally conform to the relevant sections of BS 7370 and be designed to ensure the long term establishment and development of the new landscape and planting design.

7.15 Wayfinding & Signposting

External wayfinding strategy

7.15.1 The movement of people through a hospital site is one of the key factors to the successful scheme. Wayfinding considers the different aspects regarding this and creates a system which responds to the requirements of each separate situation. The Contractor should create a unique identity for the hospital by providing an integrated solution between signage, architecture, interior design, landscape and art. The solution should provide a clear strategy for patients, visitors and staff whilst also assisting people with restricted mobility, impaired vision and language difficulties.

7.15.2 The Contractor should in their wayfinding proposals consider the prominence of architectural and interior landmarks on the site as well as colour coding, imagery, sign types and fonts etc. to create a visually stimulating family of signs as well as providing a system which conforms to current legislation. The Planting and landscape design shall assist with wayfinding and route marking around the site and provide identity to the different spaces within and around the site.

7.15.3 The solution should eliminate doubt and uncertainty in a potentially anxious environment by providing information at the right points as well as architecturally designed areas of interest and comfort. The accessibility of the site will be enhanced by a successful wayfinding system.

7.15.4 It is the Board's intention that Contractor's should incorporate electronic information points utilising touch-screen technology in addition to the manned reception points and stations internal to the building and the PA system. These information points should be located externally at appropriate locations and should present information (in a variety of languages) on the hospital for orientation and wayfinding purposes along with information in relation to the public transport hub which should be adjacent to the main entrance giving real time information on bus/fastlink timetables. The Contractor will be required to provide a clear strategy for the provision of these information points.

7.15.5 The above should be integrated into a clearly defined arts programme, which from the beginning of the project develops a strategy considering the site as a whole.

7.15.6 The following criteria require to be incorporated in the Contractor's external signage proposals;

a) all signage (internal and external) to be provided by the Contractor;

b) the signs will be exposed to the elements and therefore will require to be robust, accident proof, vandal resistant and weather proof;

c) the signs will be mounted generally on grey ppc steel posts fixed to concrete bases, the signs are to be a matt aluminium finish;

d) all light units to signs should be externally located to be easily accessed and maintained;

e) overstuck lettering is not acceptable; and

f) traffic signage to be compliant with Transport Scotland guidance;

As a minimum the Board would expect the following external signage to be incorporated, signage to be a Hospital Campus (i.e. whole existing and new hospital) wide integrated solution:

Location	Function/Type	Identity Requirements
All vehicular, pedestrian, cycle entrances to the site	Facility Identification	All external signage requires to be as NHS Identikit Guidelines and as such feature the following ; • NHS Greater Glasgow & Clyde Identity incorporated. • Generally white background with NHS Scotland dark blue text in Stone Sans type face. • Colour on external signage to be NHS Scotland Dark Blue or Light Blue only. • If required to identify for example entry only for ambulances – this can be reversed to light/dark blue background with white text. • Signage size , height and text size should be appropriate to location and function • The limited incorporation of the caring device is acceptable. • Directional signage should indicate arrows and text ranged according to the direction. • All external signage will require to be clearly illuminated. • Matt Finish to all external signs. • Built up brushed stainless steel lettering or equivalent standard finish to signage will be expected to be incorporated at key areas of public prominence – entrances, receptions, atria, main circulation.
Vehicular routes through site	Building Identification	
Vehicular routes through site	Car Park Location – directional / Availability of Spaces	
Car Park entrances	Identification of Car Park entrances	
Car Park	Identification of disabled designated spaces	
Pedestrian and vehicular routes through site	Building Location - directional	
Building Entrances	Identification of Building entrances	
Building Entrances	Identification of Building	
Building Entrances	Building Directory – indicating key departments	
Vehicular routes through site	Identification of ambulance only / service only routes/entrances and helipad	
All locations	Statutory Signage	As guidance requirements

Internal wayfinding strategy

7.15.7 Design solutions shall present an integrated and comprehensive wayfinding solution that enables patients, visitors and staff to self-navigate the Facilities with ease. The wayfinding solution must comply with the DDA, meeting the needs of people with physical and/or sensory disabilities/impairments, and those with literacy difficulties. It shall add value to the internal environment and could be a component of the comprehensive arts programme.

7.15.8 Way-finding is a critical part of the building functionality, and must guide patients and visitors to their desired destination in the most efficient manner possible. It should be borne in mind that people using health buildings may be easily disorientated due to illness and / or upset; they may be in unfamiliar surroundings; they may have difficulties with sight, hearing, mobility or learning; they may not have English as their first language; or they may need information presented at a lower level because they are in a wheelchair.

7.15.9 An audit of the signage within the Facilities shall be completed with the Board prior to Completion to ensure that the signage is complete, and that no ad hoc signs are required to complete the wayfinding scheme.

7.15.10 The following criteria require to be incorporated in the Contractor's proposals:-

a) all lift and door signage should incorporate the use of braille;

b) all signage and signage fixings must be robust and vandal resistant;

c) colour contrasted or tactile variation flooring clues should be provided to main reception area to guide visually impaired people to reception desk point at 90 degrees from circulation route. Clear orientation markers/signals are required at changes in direction at all entrance routes and main entrance;

d) There is an expectation that the signage will require to incorporate additional colour and/or images in line with the overall wayfinding strategy. The Contractor will require to provide a clear demonstration of this approach, which may for example assign colour on a departmental or level by level basis or to identify and differentiate the Children's Hospital. However any colour strategy developed for signage should be within the standard colour ranges identified (including tints) within NHS Identikit Guidelines. Any adoption of images on signage as part of this strategy will require to be developed in conjunction with the Board; and

e) In order to provide staff, patients and visitors with access to information especially at the key points of entry to the Works it is required that the Contractor shall incorporate electronic information points utilising touch-screen technology in addition to the manned reception points and stations and the PA system. These information points should present information (in a variety of languages) on the hospital for orientation and wayfinding purposes along with information in relation to the public transport hub which should be adjacent to the main entrance giving real time information on bus/fastlink timetables. The Contractor will be required to provide clear proposals for the provision of these information points.

7.15.11 The Contractor is required to comply with the relevant NHS Publications in relation to signage and must include the following provision;

Location	Function/Type	Identity Requirements
Main Entrances	Facility Identification	All internal signage requires to be developed from NHS Identikit Guidelines and as such feature the following ; • NHS Greater Glasgow & Clyde Identity incorporated. • Generally white background with NHS Scotland black text in Stone Sans type face. Other background colours can be considered – within NHS Identikit colour ranges identified. • Signage size, height and text size should be appropriate to location and function. • Directional signage should indicate arrows and text ranged according to the direction. • Matt Finish to all internal signs • Monolith, ceiling fixed or wall mounted signage types are acceptable for internal signage. • Illumination should be incorporated for signage within areas of public prominence – for example main entrances, atria, key receptions etc.
Main Entrances	Building Identification	
Main Entrances	Reception Identification	
Main Entrances	Building Directory – Identifying department locations on a floor by floor basis – featuring building plan.	
Main Entrances	Department Locations - Directional	
Main Entrances	Identification of key facilities – Toilets , Stairs, Lifts etc	
External to Stairwells	Level Directory	
Inside stairwell	Stair Identification	
Lift Car	Level Directory	
Corridors	Departmental Locations - Directional	
Corridors	Identification of Exits - Directional	
Departmental Entrances	Identification of Departmental entrances	
Departmental Entrances	Departmental Directory	
Departmental Entrances	Reception Identification	
Departmental Corridors	Key Locations - Directional	
Departmental Corridors	Room Identifiers (Every Room)	Room signs to feature the following; • Signs should be adjacent to doors at a height of 800–1500 mm and tactile (Braille) so that they can be easily read by touch. • Room name • Room number • Occupant name (should be removeable)
All locations	Statutory Signage	As guidance requirements

7.16 Protection

7.16.1 The Contractor shall be required to demonstrate that their proposal provides the most effective height / location and orientation of protection that shall prevent direct impact with the building fabric.

7.16.2 The Contractor is required to comply with the relevant NHS Publications in relation to protection and must include the following provision;

Location	Protection	Handrail
All main communication routes/main corridors between departments	Heavy Duty ; Mid-height handrail and either durable material on lower part of walls, or lower height crash rail, and with splayed skirtings in main corridors. Corner protection also required.	Handrails required. Handrails should return into recessed doorways and openings, but otherwise be continuous to aid navigation.
Hospital Street / Building Entrances	Severe duty; Mid-height handrail or crash rail, lower height crash rails and splayed skirtings. Corner protection also required.	Handrails required. Handrails should return into recessed doorways and openings, but otherwise be continuous to aid navigation.
Departmental Corridors; All wards	Heavy Duty ; Mid-height handrail and either durable material on lower part of walls, or lower height crash rail, and with splayed skirtings in main corridors. Corner protection also required. Bed locators where required.	Handrails required. Handrails should return into recessed doorways and openings, but otherwise be continuous to aid navigation.
Operating Theatres	Rails may be omitted in favour of overall durable, washable finishes. In practice the greater care shown by the theatre users appears to compensate for the lower level of protection.	None required.
Workshops, storerooms etc	May be constructed of materials which are not necessarily given a decorative finish, or applied protection. These materials include brickwork, blockwork and concrete.	None required.

7.16.3 The Contractor will also be expected to provide, as a minimum the following provision;

a) where handrails and wall protectors are provided a minimum vertical clearance of 50 mm must be maintained between the handrail and wall protector and a minimum horizontal clearance behind the handrail of 75mm;

b) where the wall protector protrudes in front of the handrail, the clear width of the corridor will be to the wall protector; and

c) handrails should be easily visible, that is, contrast visually with the surface to which they are fixed, smooth and free of any abrasive elements, neither too cold nor too hot to the touch.

7.16.4 The Contractor shall undertake a detailed review of those pieces of mobile equipment both Clinical and Non-Clinical, that is expected to be used by the Board and The Contractor within the Works. This review shall include a process of risk assessment and shall be organised to determine the type and extent of protection that is required to the building fabric. This review shall be made available to the Board as requested.

7.16.5 The Contractor shall endeavour to minimise the extent of impact damage incurred by ensuring corridors are and free awkward comers / obstructions. The Contractor shall ensure that doors and lifts are of sufficient width to accommodate all forms of hospital traffic and shall, where necessary, be designed to be normally held in the open position or to automatically open where appropriate.

7.16.6 In line with health building guidance, continuous hand-rails should be fitted to both sides of all patient accessible routes and corridors. Certain proprietary handrails have also been developed as wall protection crash rails. A combination of these hand rails or some of the following forms of protection would be deemed appropriate in patient and non patient routes and corridors:

a) crash rails;

b) defensive coves; and

c) corner treatment and reinforcement.

7.16.7 Exposed services such as ducts, radiators and pipework can be badly damaged when struck by trolleys etc. The Contractor shall incorporate measures to avoid damage to these elements.

7.17 Integration of Healing Arts Strategy

7.17.1.1 Introduction

Art and Architecture is a key strand of the Board's Arts and Health Strategy. The Board recognises that good design in healthcare buildings makes a measurable difference to the experience of patients, visitors and staff.

7.17.2 As part of it's Design Action Plan, the Board are committed to the development and integration of Art and Therapeutic Design within the new developments at Southern General Hospital and this will include;

a. New Adult Acute Hospital;

b. New Children's Hospital;

c. New Laboratory Block (part of novated design); and

d. External space and general landscaped areas within the site boundary.

7.17.3 The Art strategy will be developed in the context of;

a. current Board arts strategy work already being undertaken in Glasgow as part of ASR I and the new Maternity Unit at Southern General Hospital;

b. the range of cultural, regeneration, funding partnerships already established within Greater Glasgow and Clyde; and

c. the need to ensure a local arts perspective is developed that reflects international level of quality.

7.17.4 Competitive Dialogue Stage (May - September 2009)

Bidders are asked to clearly demonstrate within their written and drawn responses how they will develop and deliver an Arts and Therapeutic Design Strategy that reflects:

a. Integrated art, specimen art, interior design and landscaping (e.g. stained glass, bespoke art, special lighting, floor designs, therapeutic colour choices, special procurement of non clinical looking furnishings, landmark way finding, gardens and sensory planting);

b. Art enabling works (e.g. electrical infrastructure, lighting, wall niches and strengthened walls and ceilings to host future art works);

c. The provision of programmable spaces (e.g. future exhibitions, performance or sculpture); and

d. Architectural elements (e.g. entrance canopy, art doors, curved walls, specially designed stairways and car parks);

7.17.5 Bidders are asked to prepare a detailed proposal of how they will provide resources and capacity to support the Board's aspirations to develop and deliver this strategy in conjunction with a wide range of stakeholders including patients, managers, clinicians and fundraisers ensuring that the Art strategy and design proposals are fit for purpose and in line with contract management/ build timelines.

7.17.6 Broad Plan for Developing and Delivering an Arts Strategy

The Arts strategy should be developed with a tiered approach based on priority areas for art and therapeutic design to be implemented on a discretionary basis reflecting levels of finance available. The table below gives an indicative format, but bidders should bring forward proposals which they feel will develop the most rewarding strategy.

Bidders are strongly recommended to have dedicated resource for the inputs below in terms of architecture, arts and technical requirements.

STAGE	TASKS	RESOURCES
Stage 0 Competitive Dialogue	Develop Art Strategy as part of bid proposals. The strategy developed by your team will form part of the evaluation process.	Identify bidder resources that will be provided during Stage 2 design and anticipated costs over the time period for stage, along with assumptions on frequency of meetings etc. The proposals should therefore ring fence money and time for Stage 2.
Stage 2 Design Development	The successful bid team will develop their strategy along with Board managers and other associated groups as noted earlier. • As a key member of the Board's Arts Development Group you will meet monthly to develop, plans and incorporate a full arts strategy into the detailed designs for the new builds. Prepare detailed costs and budgets for these works for Board consideration. • Working to the Arts Development Group will be the artists and designers who will meet weekly through design development forum to discuss concepts, plans, detailed and help prepare detailed costs.	The successful bid team will be required to take forward the strategy subject to Board involvement and work with teams to develop a workable proposal that is both achievable, realistic and affordable in the run up to FBC and approval to proceed with construction of the adult and children's hospitals. Note: costs for the arts strategy may be included within the contractors price, or funded by external Board source, or from a combination of these.
Stage 3 Construction of Adult and Childrens Hospitals	Incorporate the agreed art strategy design into the new builds	Manage the construction and full integration of the approved strategy on site by the successful bid team. Attend periodic meetings (quarterly) to review progress.
Stage 4 Commissioning	Fully commission any loose art works requiring service connections.	This would occur during post handover Board equip[ping stage, detail and input from bidders would be developed during Stage 2.

7.18 Secure by Design

7.18.1 It is important that security is effective but not visible and we would seek to avoid through good design the need for overt signs of security systems such as perimeter fencing and extensive CCTV provision.

7.18.2 The principals of 'Secure by Design' promote good practice, and encourage the adoption of design principles that reduce crime prevention as opposed to adopting 'active' preventative measures, The Contractor shall provide a report detailing compliance as far as is practicable with Secure By Design certification requirements. The Contractor should liaise with the local police in refining a strategic approach to the security of the facilities and the overriding safety of staff, patients and visitors.

7.18.3 While connections to the community are encouraged, not to the detriment of security Frequently, 'single point of access' is a strategy that is widely encouraged.

7.18.4 The following are extracts from the 'Secured by Design Principals' Document (2004):

a) Access design and escape routes;

To satisfy the requirements of individual developments, and in the interests of good urban planning, new development must provide adequate access to meet functional and recreational needs, including for example paths and inter-connecting open spaces, and access for emergency services. However multiple footpaths and points of access can make crime easier to commit by providing a choice of alternative escape routes from the scene of a crime. Careful attention to the disposition and design of access, and in some cases limiting the means of access to developments and to buildings, can assist in reducing opportunities for a crime, be it illegal entry, vandalism, crimes against the person or vehicle theft. Uncontrolled rear access ways to buildings and footpaths that are unduly secluded provide opportunities for crime with a low risk of detection and are to be strongly discouraged. It may on occasion be necessary to restrict access to a development to one main point, and it is always advisable to carefully consider the desirability and design of secondary access routes;

b) Footpaths and cycleways;

Public footpaths and cycle ways form a vital part of the communications network in both urban and rural settings. They also provide an important local or strategic recreational amenity. Their provision is strongly encouraged by current government planning guidance, but awareness is need of the potential problems that poorly located or poorly design footpaths can have. They can, for instance provide opportunities for unobserved access to the rear of buildings, means of escape for offenders and opportunities for crimes against people. Furthermore, poorly designed or sited footpaths may cause users to feel ill at ease and give rise to fear of crime, particularly after dark. This is likely to lead to reduced levels of use, which reduces the benefit to the community and will in turn exacerbate the problem. Well designed, well used and well maintained footpaths on the other hand provide fewer opportunities for crime and are likely to feel safer;

c) Relevant Secured by Design Key points:

i) Superfluous and unduly secluded access points and routes should be avoided;

ii) Access points to the rear of buildings should be controlled, for example by means of lockable gates;

iii) In terms of security, the design of the footpath of equal importance to the design of the building. The standard combined cycleway/footway should be 3m wide as a minimum and footways 2m wide as a minimum. Any shrub planting should start at the back of the verges;

iv) The position of the planting and choice of species should be such that hiding places are not created;

v) Good visibility should be maintained from either end, and along the route of footpaths and cycleways. Sharp changes in direction should be avoided;

vi) Footpaths and cycleways should not generally be routed to the rear of the buildings, but if this is unavoidable a substantial buffer should be planted between a secure boundary fence and the footpath margins, with planting designed so as to discourage intruders;

vii) Footpaths and cycleways shall be lit in built-up areas to adoptable street lighting standards except where the route is passing through woodland or and ecologically sensitive area, in which case an alternative lit route should be made available, such as a footway alongside a road; and

viii) Alternative routes to important destinations may be beneficial, although a balance has to be struck between advantages of greater choice and perceived security against the disadvantage of providing additional means of escape or of encouraging inappropriate movement of people.

Section 8.0 Building Services Requirements

8.1.1. Introduction

8.1.1.1. The Contractor shall in carrying out the Works comply with the following non-exhaustive list of Mechanical & Electrical requirements.

8.1.1.2. The Contractor shall provide an engineering system that utilises the latest technology to create a high quality working environment that will provide an efficient hospital for all patients, their families, visitors and staff. The Contractor shall ensure the services network is efficient, effective, flexible and unobtrusive to the clinical functions. The Contractor shall ensure that the system is easy to maintain and shall maximise the opportunities for flexible adaptation and extension of The Works.

8.1.1.3. The heating and cooling mediums shall be selected to ensure the most efficient systems are utilised taking into account integration of low carbon technologies and the site wide interconnectivity requirements.

8.1.1.4. Mechanical, Electrical, Public Health and Specialist services shall be designed to be an integral and co-ordinated part of the overall scheme. Services shall be clearly identified at regular intervals and at all locations where maintenance access is required.

8.1.1.5. Plant access shall be prioritised in all aspects of the building services design to minimise the requirement for the use of portable access equipment.

8.1.1.6. Permanent access equipment shall be provided by the Contractor to allow routine maintenance of all equipment within all plant rooms and associated areas where items of plant are located.

8.1.1.7. A systematic plant replacement strategy shall be provided by the Contractor, this shall detail the works required for the replacement of all major plant items and their major components.

8.1.1.8. All access equipment including lifting beams, access platforms, equipment cradles, slings, block and tackles and access ladders to allow all plant to be replaced in accordance with the strategy shall be provided by the Contractor with each item of equipment cross referenced to the plant items within the replacement strategy.

8.1.1.9. The location of engineering and utility services shall be co-ordinated with the structure and not constrain or conflict with clinical functionality.

8.1.1.10. Access to all services shall facilitate ease of maintenance which should be safe and able to be effectively undertaken. There shall be provision for space to give flexibility for future re-planning and / or re-modelling and replacement of the services.

8.1.1.11. The Board requires the buildings to be designed to achieve a very efficient level of energy and utility utilisation in accordance with the energy targets noted in Appendix M&E4 .

8.1.1.12. The Contractor shall take cognisance of all the building services implications of the requirements described in the Employers Requirements.

8.1.1.13. The power distribution systems and final circuits where required shall incorporate, IPS and UPS systems to meet the requirements of (S)HTM06-01 together with full compliance where appropriate with the MEIGaN requirements.

8.1.1.14. UPS to be provided from resilient platforms with N+1 redundancy with ability to transfer to shunt by-pass without loss of load, these shall be distributed throughout the works to ensure that reliable interruptible supplies are provided to suit the hospital operations.

8.1.1.15. Open protocol industry standard format must be used for all elements of the Electrical, Mechanical, Public Health Medical Gases, Security and Specialist systems.

8.1.1.16. All systems shall be warranted for support for an extended period and all software shall be retro compatible.

8.1.1.17. All Mechanical, Electrical, Public Health and Specialist system plant shall be designed and installed in modular arrangements incorporating plant N+1 redundancy to minimize disruption during planned maintenance.

8.1.1.18. All Mechanical, Electrical, Public Health and Specialist systems shall be designed and installed in resilient arrangements with dual distribution paths and appropriate isolation facilities to ensure that the completed installations meet all operational, maintenance, servicing together with plant replacement requirements and that local maintenance does not disrupt adjacent areas.

8.1.1.19. Where contradictory advice is apparent, the most recent guidance shall generally take precedence; unless indicated otherwise in the main compliance section of the Employer's Requirements – Volume 2.1 Section 5.1.

8.1.2. Engineering Services Interface with Building Fabric and Service Routes

8.1.2.1. The Contractor shall ensure that co-ordination of the Electrical, Mechanical and Communication services shall form an inherent part of The Works design.

8.1.2.2. Services provision, e.g. luminaires, fire alarms, security and mechanical services, shall be co-ordinated with the ceiling layout and allow simple relocation if required.

8.1.2.3. Access to services shall be provided and the services clearly identified at regular intervals and at all locations where maintenance access is required, for example at valves and electricity connection points. Access to building services shall be in accordance with SHTM 2023 "Access for Engineering Services".

8.1.2.4. It shall not be acceptable to require other services to be removed to allow access to services.

8.1.2.5. The positioning of sockets, light switches, alarm buttons and fire “break-glass” panels etc shall be consistently located throughout the hospital buildings and to specifications set out in BS8300, unless specific clinical needs take precedence.

8.1.2.6. Structural design shall ensure that structures are co-ordinated to ensure the logical and sequential installation and maintenance of services. For example the use of columns adjacent to vertical service voids shall be avoided.

8.1.2.7. All Mechanical, Electrical, Public Health and Specialist systems shall be fully co-ordinated in 3D with prefabricated plant, escalators, lifts, the building fabric and structural frame, secondary steelwork, façade systems, fit out to ensure that the completed installations meet all operational, maintenance, servicing and plant replacement requirements.

8.1.2.8. The Contractor shall provide secure utilities services connection to those services which are;

a) to be taken directly from public and other utilities; and

b) to the point of supply (inc connection) for those utilities which are to be taken from the Board.

8.1.3. Service Routes

8.1.3.1. All service voids, risers and other spaces shall allow for installation of additional services and shall provide a defined reserve of a minimum 25% of useable area through routing cross sectional area. All isolating valves and other items requiring particular access shall be positioned at convenient locations with permanent access provision and which do not impede execution of the clinical functions of the space.

8.1.3.2. The Contractor shall provide a compliance matrix indicating the level of provision of each service together with the means of calculation of the required 25% reserve capacity.

8.1.3.3. Services shall be arranged in a clearly zoned spatial hierarchy in ceiling voids, risers and plant spaces.

8.1.3.4. Generally access to services shall not be given in clinical areas, where this is unavoidable due to the requirement for local access the Contractor shall ensure that all services are co-ordinated and grouped to minimize the number of access hatches.

8.1.3.5. Ceiling void depths in Theatres shall be minimized, and in all cases be less than that required for void protection, with all power and data wired in a loop in basis to allow rewiring without the requirement to access the ceiling void, where access is required to allow periodic inspection of fixings, this shall be accommodated by the apparatus trims and via light fitting openings.

8.1.3.6. Services shall be configured to ensure local maintenance and isolation can be carried out in each room without the requirement to take other rooms out of use.

8.1.3.7. All service voids, risers, plant rooms and other service / plant spaces shall be designed to easily facilitate the future removal and replacement of building services within each space.

8.1.3.8. In order to minimise potential disruption to the Board due to maintenance of building services, The Contractor shall route services through common spaces such as corridors and avoid through routing within department areas.

8.1.3.9. All ductwork shall be provided to allow cleaning of internal surfaces and components to be undertaken in accordance with the Health and Safety Approved Code of Practice 33, and as detailed in the HVCA Document TR17 Cleanliness of Ventilation Systems.

8.1.3.10. Plant rooms shall be configured and constructed to minimize the risk of water penetrating into Critical operational areas. This is a pre-requisite of the design and the Contractor shall provide a detailed strategy document indicating the risk assessments and mitigation measures proposed e.g. water tanks not located above Critical operational areas, plant room floors constructed to prevent water seepage, tanking to be integrated in construction detailing rather than ad hoc post installation details, appropriate location of floor gulleys and sensitive routing of water and drainage pipework.

8.1.4. Server and Nodal ICT rooms

8.1.4.1. Major leak detection shall be incorporated complete with automatic zoned shut off valves.

8.1.4.2. Water proof ceilings to be provided in all Server and Nodal ICT rooms.

8.1.4.3. Resilient redundant environmental engineering services shall be provided within the Server and Nodal ICT rooms. The rooms shall be configured and located to minimise the risk of water damage from all sources with the following minimum requirements:

a) No overhead water, condensate or drainage pipework allowed within ICT rooms; and

b) No water tanks, tea points, DSR's, Cleaners rooms, toilets or showers etc. to be located directly above ICT rooms.

All ICT rooms to be clinically cleaned prior to the installation of active equipment, this deep clean shall be carried out by the Contractor's specialist cleaners to an agreed Board specification by the relevant Board Representative and a certificate issued. Special care shall be taken in advance of the deep clean with ongoing general cleaning being carried out at regular intervals to ensure that the cable termination works are carried out in accordance with the manufacturer's recommendations.

8.1.5. Engineering Flexibility and Zoning

8.1.5.1. All Mechanical, electrical, public health and specialist systems including medical gas zoning shall be configured to promote flexibility in order to enable re-modelling, re-planning and replacement to be undertaken at a future date.

8.1.5.2. All engineering services shall be zoned with isolation and safety provision for the whole of the the Works and for individual wards and departments. The Contractor shall also ensure that zoning accounts for:

a) The requirement for “dirty” / “clean” separation;

b) Solar movement; and

c) The necessity for isolation of part of the Works without affecting the entire facilities e.g. all theatre suite services including, ventilation, water, power, medical gases, lighting and controls etc. shall be capable of being independently isolated for maintenance with the remaining theatres still in service.

8.1.5.3. The Contractor shall ensure that all sections of the services distribution can be taken out of service for maintenance without interruption of the water, gas, medical gas and electrical supplies to the adjacent areas; this shall be detailed in the systematic plant replacement strategy noted in the introduction 8.1.1.

8.1.5.4. It is a pre-requisite of the design that all services to individual Theatres and other Critical operational areas can be isolated for maintenance, repair and replacement without the need to effect the ongoing operation of the other facilities.

8.1.5.5. Specifically each Theatre shall have individual air handling units and associated controls. The air handling strategy in Critical Care areas shall be developed with the design layout to minimize disruption during maintenance and each air handling unit must not serve more than one Critical Care pod. Also Air handling units in isolation facilities in Critical Care and general areas shall be configured in accordance with SHBN04.

8.1.5.6. Air handling strategy for the large recovery areas shall be developed with the design layout to minimize disruption during maintenance with the provision of interwoven duplicated systems and sectional controls.

8.1.5.7. Air handling strategy for the large decontamination areas shall be developed with the design layout to minimize disruption during maintenance with the provision of interwoven duplicated systems and sectional controls.

8.1.5.8. Air handling strategy for all large areas shall be developed with the design layout to minimize disruption during maintenance with the provision of interwoven duplicated systems and sectional controls.

8.1.5.9. No exposed pipework shall be visible in clinical areas.

8.1.5.10. Controls at nurse bases shall be co-ordinated with all alarm panels to improve aesthetics and ensure simple operation.

8.1.5.11. Patients operated environmental controls shall be provided to allow set point variation via a graduated slider with arrow type legend (rather than temperature levels); the local set point bandwidth adjustment shall be controlled from group settings at the BMS front end.

8.1.5.12. Emergency shut offs shall be provided at appropriate locations for all services.

8.1.6. Energy Targets

8.1.6.1. The buildings and building services solutions shall provide sustainable, low carbon, low energy facilities in accordance with Appendix M&E 4.

8.1.6.2. The Contractor shall comply with the requirements relating to energy targets as specified in Appendix M&E 4.

8.1.6.3. The Contractor shall provide a breakdown of how the target energy consumption shall be achieved. In particular, the Contractor shall provide details of the anticipated electrical and gas consumption of The Works.

8.1.6.4. In order to assist in meeting this target, the Contractor shall incorporate a high level of innovative building automation and equipment monitoring. The Contractor shall ensure that a central Building Management System (BMS) for The Works is in place, providing linked control and monitoring of the estate functions. Refer to Appendix M&E 5 for details.

8.1.6.5. The Contractor shall note that the Building Volume used in the calculation of Energy Consumption Performance Indicators shall be the “Heated Volume” as defined in Encode. The Contractor shall also include services within the calculation for determining the energy consumption.

8.1.6.6. The Contractor shall calculate the energy consumption for the new buildings using weather data from CIBSE Guides, and degree-day data. The Contractor shall submit all assumptions used to the Board for comment.

8.1.6.7. In order to assist in achieving the water consumption target noted in Appendix M&E 4. The Contractor shall use water saving measures including but not limited to:

a) Low Flush Toilets;

b) Automatic Sensor Taps;

c) Flush Controls to Urinal Facilities;

d) Major Leak Detection and Automatic Shutdown; and

e) Flow restrictors (if risk assessment accepted)

8.1.6.8. Consideration shall also be given to the possible use of borehole water.

8.1.7. Thermal Comfort

8.1.7.1. It is a requirement of the Contractor's Bid Submission that a maximum temperature (28 degree C) solution be considered for the whole of the Works. This will be discussed with bidders during the bid process. Such a solution would require to be produced with the following supporting information;

a) Capital Costs;

b) Lifecycle & Maintenance Costs;

c) Additional Electrical etc loadings; and

d) Projected Energy costs.

8.1.7.2. Where maximum internal summer time temperature calculations of ventilated rooms indicate that the internal temperature will exceed those limits set out in the Appendix M&E 3 for frequent periods, the Contractor shall provide means of reducing the temperature rise.

8.1.8. Air Quality

8.1.8.1. Internal

8.1.8.2. Air quality in all areas shall take account of occupancy levels, internal pollutants, heat gains, external pollutants, atmospheric conditions and shall be controlled to provide adequate comfort and fresh air levels appropriate to the functions of each department area.

8.1.8.3. Particular attention should be given to the risk of cross infection within the hospital / healthcare environment and shall be such as to minimise the spread of infection, all systems to comply with Hai-Scribe and infection control requirements.

8.1.8.4. The Contractor shall demonstrate how their proposals facilitate the control and management of an outbreak and spread of infectious diseases, and in particular shall comply with the requirements of SHTM 2025 (Ventilation in Healthcare Premises) and Hai-Scribe. In order to reduce cross-contamination, the design of The Works shall incorporate 100% fresh air supply systems only.

8.1.8.5. The Contractor's demonstration shall cover all aspects of the building, its services, spatial relationships, PPM Regime and incorporate requirements of the Board's Infection Control Team.

8.1.8.6. Consideration shall be given to the odours from the adjacent sewage works and appropriate filtration shall be included to reduce odours entering the facility.

8.1.8.7. Special consideration shall be given to the reduction of strong smells within the Children's hospital in accordance with SHPN23.

8.1.8.8. External

8.1.8.9. The Contractor shall comply with the requirements of Glasgow City Council and other Statutory Bodies regarding airborne emissions from the Site and shall undertake all studies necessary to prove that emissions and their dispersal will not have any adverse impact on the local community or staff, patients and visitors to the Site.

8.1.8.10. All works shall comply with the Clean Air Act. 1993.

8.1.8.11. The Contractor shall ensure that all Cooking Odours/Fumes are disposed off and do not cause a nuisance to the local community or staff, patients and visitors to the Site in accordance with Planning Condition 17 (see Outline Planning Conditions documents in Appendix D).

8.1.9. Vibration

8.1.9.1. The Contractor shall ensure that Building Services Plant and Equipment are suitably isolated from the building structure in order to prevent the transmission of vibration. The Contractor shall comply with the guidance on the satisfactory magnitude of building vibration with respect to human response given in BS 6472. The Contractor shall comply with the following vibration limits detailed below:

a) Plant rooms on occupied floors 0.015 m/s^2;

b) Plant rooms above and below occupied floor levels 0.050 m/s^2; and

c) Remote plant rooms 0.100 m/s^2.

8.1.9.2. All mechanical ventilation, air conditioning and electrical plant shall be suitably isolated from the structure of the building and fan units positioned in a ducted system shall be isolated from the ducting by means of flexible connections in accordance with Planning Conditions 12 (see Outline Planning Conditions documents in Appendix D).

8.1.9.3. To minimise structure borne noise or vibration lifts and/or hoists, including doors, guide rails and ancillary plant shall be suitably isolated from the structure of the building connections in accordance with Planning Conditions 13 (see Outline Planning Conditions documents in Appendix D).

8.1.9.4. The Contractor shall establish, in consultation with the Planning Authority, whether Best Practicable Means shall be employed as an approach to control noise or whether a baseline noise survey is required. If the latter is deemed necessary the procedures to be adopted shall be agreed in writing with the Planning Authority and thereafter implemented in the agreed manner. When detailed method statements for construction are available an assessment of hospital noise and vibration sensitivity should be undertaken and adequate controls put in place prior to the commencement of any construction demolition works in accordance with Planning Conditions 15(see Outline Planning Conditions documents in Appendix D).

8.1.9.5. All plant and systems shall be installed to meet the vibration requirement of the Clinical Equipment, including theatres and micro biology microscopes etc.

8.1.10. Acoustics

8.1.10.1. The Contractor shall ensure effective control of building services noise and provide a satisfactory acoustic environment in accordance with the following levels as per (S)HTM 08-01. This shall be developed with the Contractors Acoustician to ensure that a holistic approach is taken to prevent nuisance noise, as detailed in Appendix S – Acoustic Requirements.

Table 2 Criteria for internal noise from mechanical and electrical services		
Area type	**Example**	**Noise from mechanical and electrical services**
Ward areas, sleeping areas	Single-bed ward, multi-bed ward, on-call rooms, relatives' overnight stay	NR 30
Recovery	Recovery rooms	NR 35
Small office-type spaces	Private offices, treatment rooms, interview rooms, consulting rooms	NR 35
Open clinical areas	A&E	NR40
Circulation spaces	Corridors, hospital street, atria	NR40
Public areas	Waiting areas, dining, playroom	NR40
Personal hygiene (en-suite)	Toilets, showers	NR40
Personal hygiene (general access)	Toilets, showers	NR45
Small food-preparation areas	Ward kitchens	NR40
Large food-preparation areas	Main kitchens	NR 50 (NR 55 below extract hoods)
Large meeting rooms (>35 m2 floor area)	Lecture theatres, meeting rooms, seminar rooms, board rooms, classrooms	NR30
Small meeting rooms (≤35 m2 floor area)	Meeting rooms, seminar rooms, board rooms, classrooms	NR35
Operating theatres (excluding laminar flow theatres)	Operating theatres	NR40
Laminar-flow theatres	Ultra-clean theatre	NR50
Laboratories		NR 40 where laboratory has no fume cupboards NR 60 at 1 m from fume cupboard with open sash
Table 2 Criteria for internal noise from mechanical and electrical services		
Area type	**Example**	**Noise from**

		mechanical and electrical services
Utility rooms	Clean utility, dirty utility	NR40

8.1.10.2. As well as complying with the technical requirements noted within the various hospital documents, the Contractor shall develop a managed approach with all designers and the acousticians to provide a holistic solution in areas where low level noise could create potential problems e.g. courtyards, entrance halls etc.

8.1.10.3. The Contractor shall include active solutions were these are deemed appropriate e.g. provide piped music in atria, changing rooms to assist acoustic performance.

8.1.10.4. Noise from, or associated with the completed development (the building and fixed plant) shall not give rise to noise level, assessed with windows closed, within any dwelling or noise sensitive building in excess of that equivalent to Noise Rating Curve (NRC) 35 between the hours of 0700 hours and 2200 hours and Noise Rating Curve (NRC) 25 at all other times in accordance with Planning Conditions 11 (see Outline Planning Conditions documents in Appendix D). Refer to appendix M&E3 and the general acoustic requirements noted in section 7.8 - Acoustics.

8.1.11. Plant Life Cycle Costs

8.1.11.1. The Contractor shall ensure that all plant and systems are selected and configured to provide high quality, efficient, resilient, modular flexible and maintainable Building Services solution.

8.1.11.2. The Contractor shall provide evidence of plant life cycle costings including:

a) Capital Cost;

b) Energy Running Cost;

c) Maintenance Cost;

d) Replacement Cost.

8.1.11.3. Warranty costs for each of the building systems shall be benchmarked against industry standards and backed up by detailed costings in the extended warranty schedules.

Sustainability, Renewables, Low, Zero Carbon Technologies

8.1.11.4. The Contractor shall provide evidence of compliance with the Energy Target requirements as detailed in Appendix M&E4 and section 10 and shall develop the sustainability brief in conjunction with the Local Authority to ensure compliance with:

a) Building Regulations;

b) BREEAM Healthcare Excellent requirements;

c) Building Control;

d) Glasgow City Council requirements;

e) Scottish Government Planning Policies including SPP6;

f) Advice Notes including PAN84;

g) NHS/Board objectives.

8.1.12. Design Criteria

8.1.12.1. The Building Services shall be designed in conjunction with the development of the Architectural and Structural packages to ensure a holistic approach to minimise energy use while maintaining user comfort, fabric protection and statutory compliance.

8.1.12.2. All Mechanical, Electrical, Public Health and Specialist system plant shall be designed in modular arrangements incorporating plant N+1 redundancy.

8.1.12.3. All Mechanical, Electrical, Public Health and Specialist systems shall be designed and installed in resilient arrangements with dual distribution paths and appropriate isolation facilities.

8.1.12.4. The lighting levels shall be in accordance with CIBSE guides and Building Control requirements.

8.1.12.5. Power shall be configured to meet the Target Energy demands and also the design peak load plus 25% capacity for future growth.

8.1.12.6. The growth shall be provided in a modular configuration to allow plant cycling and high efficient running.

8.1.12.7. Fire safety systems shall be provided in accordance with the Fire Strategy.

8.1.12.8. Fire alarms shall be Fire Code and BS5839 CAT L1.

8.1.12.9. Refer to Appendix M&E 3 for Room Design criteria and internal temperature frequency periods.

8.1.13. Compliance with Health Service Notes and Memorandums

8.1.13.1. The Mechanical, Public Health, Electrical, Life Safety and Lift Services shall be designed and installed in accordance with the relevant SHTM's, HTM,s, SHBN's, HBN's, SHGN's and HGN's to meet the Employers Requirements.

8.1.13.2. Refer to Volume 2.1 Section 5.0 General Design & Construction Requirements for document hierarchy and Compliance Requirements.

8.1.14. Compliance with Planning/Building Regulations

8.1.14.1. The Building Services Installations shall generally comply with the Building Regulations and Planning Requirements.

8.1.14.2. If any deviations are proposed these must be highlighted in the contractors return documentation together with the details of the proposed mitigation strategy.

8.1.15. Incoming Services - Utility Connections

8.1.15.1. General

8.1.15.2. Discussions with the supply company have been commenced by the Client and contract details are included in Appendix M&E 1.

8.1.15.3. The Contractor will be responsible for the provision of all utilities and the energy supply infrastructure to and from The Works (whether this is internal or external to the Site boundary), including:

a) Confirmation of the capacity of the proposed system;

b) Liaison with potential suppliers;

c) System development and planning;

d) Any supplies modifications to the periphery of the Site;

e) Any supplies modifications within the Site;

f) Metering and sub-metering of power supplies;

g) Metering and sub-metering of heating usage;

h) Metering and sub-metering of cooling usage;

i) Metering and sub-metering of water usage;

j) Metering required for BREEAM;

k) Strategic planning in the context of the site environment;

l) Emergency systems; and

m) Power factor correction.

8.1.16. Security of Incoming Supplies

8.1.16.1. The Contractor shall provide back up to respond to the failure of the incoming supply of Electricity, Gas and Water supplies to The Works. This shall:

a) Provide full standby generator capacity for all electrical services on an N+1 basis in accordance with the requirements and recommendations of (S)HTM 06-01;

b) Ensure that The Works are provided such that all the requirements detailed in (S)HTM 06-01 are satisfied;

c) Ensure that energy, water, power supplies, medical gases and communication supplies to and within The Works are maintained by providing standby sources of supply (eg. dual fuel boilers, standby generators etc);

d) Develop a strategy to ensure the security of the supply. The Contractor shall be required to demonstrate the feasibility of the strategy to the satisfaction of the Board; and

e) Ensure their town's water connection to the Site maintains an adequate and robust service and shall provide connection details with their proposals;

8.1.17. Water

8.1.17.1. A robust alternative town's water supply is to be provided by the Contractor to the Site from a separate sector of the Scottish Water network.

8.1.18. Site Mains Water, Fire Water, Quality & Distribution

8.1.18.1. The Contractor shall develop the Site potable and fire water networks as separate systems each arranged with adequate valving to achieve robustness in continuity of supply.

8.1.18.2. The outcome of the water survey works is awaited, it is anticipated that The Works are to be supplied from dual supplies one from Govan Road and a second from Hardgate Road.

8.1.18.3. The Contractor shall filter the Site potable water to the criteria set out in SHTN02 with 0.2 micron filtration. Pipework shall be stainless steel.

8.1.18.4. The water filtration system shall be established within the Energy Centre to provide resilient filtered water to meet the requirements for The Works.

8.1.18.5. The Contractor shall provide external isolation of water supplies to the new Facilities.

8.1.19. Incoming Power

8.1.19.1. The overall site power systems shall be integrated with the Distribution Network Operator (DNO) incoming arrangement to provide a resilient system.

8.1.19.2. Scottish Power have advised that the existing 11kV network cannot accommodate the New Hospital load; they have been requested to provide proposals to enhance their network for the development. The Contractor shall negotiate with the supplier and ensure that an integrated solution is provided to meet the new building together with the additional site requirements detailed below.

8.1.19.3. The system shall also be configured to provide power for retained estate and new build areas as indicated in Appendix M&E1.

8.1.20. Fossil Fuels

8.1.20.1. The Contractor shall be responsible, in conjunction with SGN in determining the philosophy for the provision of fossil fuels to the Site.

8.1.20.2. Options the Contractor shall consider are;

a) Un-interruptible gas supply;

b) Provision of dual fuel burners and a heating oil standby facility;

c) Installation of CHP for base load;

d) Provision of CHP to provide full campus Electrical and Heating Loads in “Island” configuration with grid as standby.

8.1.20.3. Standalone Heating Boilers are not mandatory if the bidder identifies packaged CHP plant which does not require them to provide the required resiliency and dual fuel capabilities.

8.1.20.4. Irrespective of the option proposed by the Contractor the availability criteria described elsewhere in this document must be strictly adhered to.

8.1.20.5. Natural gas is required for;

a) Space heating;

b) Limited steam generation (for humidification);

c) Combined Heat and Power systems; and

d) Catering.

8.1.20.6. The gas supply shall be provided by a new mains connection from Govan Road. The pipework shall be routed to the Energy Centre to feed the Heating Boilers, CHP plant and routed to serve localised requirements within the Works.

8.1.20.7. Twin regulators shall be provided at the gas meter, non return valves shall be fitted at fire isolation valve to avoid back pressure shutting down regulator valve on activation of the fire valve.

8.1.20.8. Automatic Isolation facility to be incorporated in all gas fire valves during fire alarm testing. Valves shall be capable of being reopened and set to work remotely via the BMS.

8.1.21. Standby Power

8.1.21.1. Electrical Supplies to the Works shall be fully backed up by on site generation as noted above and in item 8.3.31 below. The Contractor shall provide the infrastructure and plant space to allow the extension of the generation capacity to meet the additional site loads as noted above together with a 25% capacity for growth.

8.1.22. Medical Gases

8.1.22.1. A new oxygen VIE compound is to be provided by the Contractor rated to supply the combined demand of The Works and the retained estate.

8.1.22.2. The existing site systems shall be extended by the Contractor to also be capable of supplying the combined site demand, this may be achieved by the expansion of the Maternity accommodation or the establishment of a further VIE compound site, which summated with the existing Maternity storage will meet the combined demand of the the Works and retained estate.

8.1.22.3. For the purposes of the Bid, the bidder shall assume that the latter is required and shall include for a further new VIE compound to be located as per drawing G1274/U(96)01.

8.1.22.4. The Contractor shall provide all civil, builderswork and distribution pipework via a ring main distribution circuit, which should be carried through to the new building risers.

8.1.22.5. The system shall be fully compliant with current SHTM requirements.

8.1.22.6. The Contractor shall liaise closely with the Boards Supplier who will lease the VIE tanks. The contractor shall carry out all builders work, foundations, bases, blast walls together with all pipe and electrical works.

8.1.22.7. Medical gases shall be supplied and configured to suit the new Hospital requirements and retained estate requirements including:-

a) Nitrous Oxide;

b) Oxygen (as above);

c) Vacuum (Split over two systems with valved off link); and

d) Surgical and Medical Air services (Split over two systems with valved off link).

8.1.22.8. Medical air plant should be provided from 2 separate sources of supply via a ring main distribution net work, carried through to the internal risers.

8.1.22.9. Within the Children's hospital special care shall be taken in the location and covering of medical gas equipment to reduce fear while retaining full operational abilities. The proposal shall be robust, simple to use and easily cleanable.

8.1.23. IT

8.1.23.1. IT equipment/server rooms shall be established in both the new Children's Hospital and Adult Acute Hospital. The two new rooms shall be interlinked, together with associated hub rooms via a star/mesh configuration of cabling.

8.1.23.2. Distributed secondary comms rooms shall be established to allow CAT 6A cables to be run to all positions within The Works within the 90m cable length restriction.

8.1.23.3. All new incoming services shall be duplicated and presented individually at the two server rooms. Ducting and manholes to be provided to up to four providers with diverse routes for each network provider.

8.1.23.4. Distributed secondary comms rooms shall be established to allow CAT 6 Augmented (CAT6A) cables to be run to all positions within The Works within the 90m cable length restriction.

8.1.23.5. The Contractor shall ensure that his works have no impact on the security of services to the existing hospital estate during the site construction works.

8.1.24. NHS Model Engineering Specifications

8.1.24.1. The Contractor shall ensure that systems are installed in accordance with all relevant NHS Model Engineering Specifications and amendments to ensure compliance with the Technical Memorandum.

8.1.25. Service Capacity Reserve

8.1.25.1. In accordance with Good Industry Practice, all plant, plant spaces and building services systems shall be specifically designed and provided with defined reserve capacity allowances and future expansion capabilities for The Works (e.g. distribution boards with 25% spare capacity, 25% additional containment, 25% spare capacity in distribution Pipework, 25% additional plant capacity, 25% additional cooling capacity, 25% additional air handling capacity etc. for the buildings as designed). As detailed in 8.1.3.2, the Contractor to provide compliance matrix detailing how this to be delivered.

8.1.25.2. With optimum for maximum temperature variant (MV2).

8.1.25.3. This shall be demonstrated within the calculations, plant room layouts and service route drawings provided with each stage of the design build project to ensure full compliance at project completion.

8.1.25.4. In addition to the reserved capacity allowances the Contractor shall also ensure reserve capacity, service termination, zoning and general arrangement supports any future extension of the building that may be an optional feature of the Contractors Proposals.

8.1.26. Commissioning, Testing and Demonstrations

8.1.26.1. The Mechanical, Electrical, Public Health and Specialist systems shall be fully tested and commissioned in accordance with:

a) CIBSE Commissioning Code;

b) The Institute of Hospital Engineers Guidance to Engineering Commissioning;

c) Requirements of SHTN’s and SHBNs; and

d) Requirements set out in the works documents

8.1.26.2. The Contractor demonstrations are to cover all aspects of the building, its services, and spatial relationships, Soft and Hard FM and incorporate requirements of the Board’s Infection Control Team.

Refer to section 6.8 – Commissioning & Handover for details.

8.1.27. Environmental Proving

8.1.27.1. During the design stage the Contractor shall provide the Computational Fluid Dynamic requirements of SHPN57 e.g. CFD shall be used to model and prove the ventilation strategy for the works.

8.1.27.2. On completion of the commissioning of all individual systems the overall performance of the combined systems shall be demonstrated within every room within the Adult Acute and Children's Hospitals.

The following parameters shall be recorded:-

a) Space Temperature;

b) Space Humidity;

c) Space Sound Levels;

d) Controls Operation & Achieving Set Points;

e) Domestic Hot and Cold Water;

f) Air Velocities (Comfort Criteria);

g) Lighting Levels; and

h) Fire Alarm Sounders.

8.1.27.3. Trend logs from the BMS system are to be used as a record of the local conditions achieved where possible, or hand held instruments with current Calibration Certificates. All readings shall be recorded, tabulated and issued.

8.1.27.4. Measuring instrument Calibration Certificates shall be forwarded for record purposes.

8.1.27.5. Room cooling capacities shall be tested on a department by department basis by introduction of temporary heat loads to prove the system design capabilities.

8.1.27.6. This shall be carried out by the Contractor at their own cost.

8.1.27.7. The Contractor shall also carry out seasonal commissioning as detailed in Appendix U – BREAAM Guidance, to ensure full system performance i.e. Main cooling plant operation in the summer and heating plant in the winter.

8.1.28. Asset Register

8.1.28.1. The Contractor shall include for a comprehensive Asset Register to be compiled on an open protocol industry standard format for all elements of the Electrical, Mechanical, Public Health Medical Gases and Specialist systems.

8.1.28.2. The Contractor is advised that an NHS Scotland (HFS) National asset management package is currently out to tender for development, this should fully developed and implemented by the time The Works are in the construction phase, failing this the Asset Register management package should revert to industry standard current at time of construction.

8.1.28.3. The register shall be linked to the As Fitted drawings via MiCAD drawing mapping, the MiCAD should also integrate with the Labour Management Systems (LMS) to provide a fully integrated system complete with interfaces to the PPM and Board's labour resource software systems (Apollo or Eclipse).

8.1.28.4. For ease of reference, all installed Mechanical, Electrical, Public Health Medical Gases and Specialist systems components shall be asset tagged by the contractor, entered into the PPM system and linked to its full specification and maintenance schedule.

8.1.28.5. IT provision for this functionality should include for server capacity to effectively store all 3 elements, PPM, MICAD & LMS packages.

8.1.28.6. The tagging system shall be capable of simple extension to allow the Bar Coding of Hospital Equipment, and the bidders shall provide technology proposals for Board consideration.

8.1.28.7. The asset tagging system shall be interfaced with the Personal Digital Assistant (PDA) System to be utilised for Managing Building Handover and Snagging.

8.1.28.8. The Contractor shall provide and manage a computer based electronic system for the management of the handover of the building. The system shall allow a file for each room to be established, with drawings linked to the file and marked to highlight snags or defects. This system shall be configured to provide management reports on zoned and room type selection basis.

8.1.29. Planned Preventative Maintenance PPM

8.1.29.1. The Contractor should provide, as part of the contract, a full PPM manual and system (computer based software package) for all the buildings and for all building and building services elements of the project. This system will incorporate the As Fitted drawings (MiCAD format) and specifications. This schedule shall have a full planned maintenance programme of works that the FM & Estates managers can review to plan and establish their annual maintenance schedules and annual budgets. The Contractor will be responsible for the purchase and installation of the full PPM system, including pc work stations, barcode readers and tablets.

8.1.29.2. The system to be compiled on an open protocol industry standard format for all elements of the Mechanical, Electrical, Public Health and Specialist systems.

8.1.29.3. The PPM system shall be compiled at an early date with time and input included for three iterations of comments and workshops with the Estates Department to ensure that the system meets the various requirements of the Hospital Technical Publications, CIBSE,

Clinical Services and Estate's Department. The system shall be fully linked to the As Fitted drawings via MiCAD drawing mapping, to provide a fully integrated system complete with interfaces to the PPM and Board's labour resource software systems (Apollo or Eclipse).

8.1.29.4. It is understood that there may be an iterative process involved in the preparation of the information, however it is a requirement that the Contractor allows for and ensures that all PPM, Asset register, tagging, management systems and MiCAD information is fully updated to "as fitted" condition.

8.1.29.5. The Contractor shall handover a fully working system including PC's hardware, barcode readers, tablets, printers and project specific software together with system training for the Client's operators.

8.1.30. Helipad

8.1.30.1. The Contractor shall include for all services including;

a) Fire fighting systems;

b) Suppressant storage;

c) Associated drainage, lighting and vertical access; and

d) All items required to allow operation of the helipad to ensure full compliance with HBN 15-03 and CAA guides.

8.1.30.2. The Contractor shall liaise with Glasgow City Planning and the CAA to agree the proposed location and height for Energy Centre Flue and ensure that warning lights are fitted to all required parts of the development including the flue.

8.1.30.3. All warning lighting shall be installed in accordance with the CAA requirements and the lamp replacement methodology shall be included in the main Plant Replacement Strategy.

8.1.30.4. The Building Services shall be designed and installed to accommodate Compliant Helipad Operation with the inclusion of:-

a) Lighting to main energy centre flue;

b) Appropriate location and height selected for;

i. Heat rejection plant to avoid flight path;

ii. Heat rejection plant to avoid hot air generated turbulence; and

iii. Air intakes to avoid contamination from downwash; and

c) Extract ducts to avoid contamination of operators and patient's in transit.

8.1.31. Automated Material Transfer System

8.1.31.1. It is anticipated that an Automated Material Transfer System installation will be provided to reduce the requirement for manual handling and increase service efficiency, all as detailed within Appendix M&E7. The Contractor shall set out the building service and vertical transport implications to ensure that space allocation and service requirements are incorporated for docking stations and controls.

8.1.31.2. All power, controls and equipment shall be configured to ensure EMC compatibility with the robotic solution.

8.1.31.3. The building fabric and general building services installations shall be designed to accommodate the Automated Material Transfer System.

8.1.32. Radiation Protection

8.1.32.1. All required protection and amendments to the Mechanical, Electrical, Public Health and Specialist Services shall be provided by the Contractor to suit the radiation protection regime in accordance with the manufacturer's guidance HSE regulations and Technical Memorandums.

8.1.32.2. Contractor to note that all Radiation Protection measures proposed to be discussed and agreed/endorsed with/by the Boards Radiation Officer

8.1.33. Telemedicine

8.1.33.1. The mechanics of Telemedicine system shall be provided by the Contractor via the ICT network cabling infrastructure and field cabling. The PACS equipment shall be provided by the Board.

8.1.33.2. As the principal tertiary children's hospital RHSC Glasgow is actively involved in all aspects of telemedicine and the new hospital requires to be arranged and equipped to facilitate telemedicine as part of normal practice. In practice this will require:

a) The ability to plug in mobile telemedicine units throughout the clinical areas to enable clinical consultations;

b) The equipping of all teaching facilities within the hospital for the transmission and receipt of educational activities;

c) A dedicated telemedicine suite; and

d) An IT infrastructure which will enable engagement in telemedicine activities from individual offices / PCs.

8.1.33.3. Telemedicine and teleconferencing play an increasingly important role in provision of children's hospital services in Scotland through:-

a) The transmission and receipt of educational programmes;

b) Support for networked models of service delivery (regional and national); and

c) Support for direct clinical care in remote locations.

8.1.33.4. Telemedicine and teleconferencing shall also play an increasingly important role in provision of adult's hospital with similar facilities being provided.

SECTION 8.2 – MECHANICAL SYSTEMS

8.2.1. General

8.2.1.1. The Contractor shall design, supply, install, test, commission and maintain all Mechanical Building Services necessary to support the clinical activities of The Works. The following systems are indicative of those anticipated by the Board but are not exhaustive and it shall be the Contractor's sole responsibility to determine that all necessary systems (excluding Medical Equipment) are included.

8.2.1.2. Systems shall be designed, supplied, installed, tested, commissioned, and put into service all in accordance with all relevant Regulations and Standards.

8.2.2. Building Management Systems & Controls

8.2.2.1. The Contractor shall ensure that all plant can be operated in automatic mode or manual mode should a corruption in BMS software occur. Furthermore, physical bypasses shall be provided where appropriate for maintaining service, for example at control valves for critical departments.

8.2.2.2. Network communications equipment for BMS, CCTV, Access Control Systems etc. shall be housed in racks, located within environmentally controlled secure rooms. If it is proposed that these share node rooms with the main network services then suitable control measures and rack locking shall be provided.

8.2.2.3. The system shall be fully integrated with the Building Services, refer to Appendix M&E 5 for BMS requirements.

8.2.3. Metering

8.2.3.1. The Contractor shall ensure the use of meters giving high accuracy at low flow rates and that metering points give consumption in SI units including any time bands as appropriate. The Contractor shall ensure data collection and report production is by electronic systems.

8.2.3.2. The Contractor shall allow sub-metering of electricity, gas, heating and cooling usage for each individual department / ward /unit. With water consumption measured in departments and wards with high usage.

8.2.3.3. Metering shall be provided in accordance with the targeted BREEAM credits.

8.2.3.4. The BMS shall be installed to automatically read and provide trend analysis to a range of energy and water meters. All meters including those of the utility supply companies and internal sub-meters shall be automatically read by the BMS at pre-determined intervals. The Contractor shall ensure that the BMS is capable of reading utility meters on a continuous basis in order to facilitate trend analysis. The energy metering shall include (but not be limited to):-

8.2.4. Electricity

a) Main incoming HV supplies;

b) Main LV Switchboard;

c) External lighting (separate sub-meter for each car parking area);

d) All distribution boards with separate meters for power and lighting;

e) Departmental power and lighting;

f) HVAC control panels;

g) Cooling plant; and

h) Tenant areas;

For the purpose of energy estimates, hours run meters shall be provided by the Contractor for all Air Handling Unit (AHU) fans.

8.2.5. Water, Gas, Oil, Bio Fuel

Water

a) Main incoming water supply; and

b) Internal sub-meters

Gas

a) Main incoming gas supply; and

b) Internal sub-meters

Oil

a) Delivered to Site; and

b) Used on Site

Bio Fuel (if proposed)

a) Delivered to Site; and

b) Used on Site

8.2.6. Asset Management & Tracking (AM&T)

8.2.6.1. The Contractor shall also arrange for the Utility metering systems to interface with the Board's AM&T system for fiscal metering, electronic invoice & validation process.

8.2.7. Heating System

8.2.7.1. The Contractor shall provide all heating systems required to support the Board's Clinical Output Specification and to;

a) Zone and control heating circuits to provide an efficient and comfortable environment;

b) Provide valve isolation such that isolation of circuits and sub-circuits shall have minimal disruption to the remaining departments;

c) Provide 24 hour occupied (and unoccupied) wards and departments with a night set back Facilities;

d) Provide a temperature and ventilation night set-back facilities so that when departments are unoccupied they will have frost and anti-condensation protection;

e) Good quality heat emitters shall be provided to ensure satisfactory heat distribution within the area served. Heat emitters and all heating pipework shall be arranged such that in all areas, the surface temperature limits as laid down in Health Guidance Note "Safe Hot Water and Surface Temperatures" are not exceeded. Heating pipework shall not be utilised as a heat emitter within patient areas;

f) The bidder shall provide catalogue details of all proposed heat emitters; and

g) Particular attention shall be given to effective use of warm air curtains in entrance / draft lobbies.

8.2.7.2. The Heating pipework shall be thoroughly examined and tested prior to the fitting of insulation. Any site welds shall be x-rayed and a certificate issued to confirm the suitability of the completed joint for operation within the test requirements

8.2.8. Water Systems and Filtration

8.2.8.1. Cold Water Supply

8.2.8.2. The water supply system for The Works shall include two new supplies and also incorporate on-site segregated bulk water storage (24-hours). Treatment of potable cold water supplies is not acceptable and the provision of a wholesome supply from Scottish Water's mains with the minimum of storage and handling is required.

8.2.8.3. The Contractor shall design and install the domestic cold and hot water supply installations to fully comply with the requirements of;

a) (S)HTM04-01;

b) SHTM 2027;

c) SHTM 02;

d) SHTM 2040 "The control of legionella in healthcare premises - a code of practice"; and

e) Health Guidance Note "Safe Hot Water and Surface Temperatures."

8.2.8.4. Pipework shall be stainless steel with compatible accessories.

8.2.8.5. The Contractor shall include for all specialist membrane filtration treatment plant (Replaceable cartridge systems are not acceptable). The Contractor shall provide water sampling points throughout the installation in accordance with the SHTM02. Renal water treatment shall be provided by the Contractor in accordance with Appendix M&E6 with due regard for clinical requirements.

8.2.8.6. Secure local isolation via manual shut off valves shall be provided by the Contractor at all sanitary appliances and at final connection points to Equipment.

8.2.8.7. Area leak detection shall be interlinked to zoned automatic shut down valves.

8.2.8.8. Secure external isolation to the buildings shall be provided by the Contractor. Sentinal taps for testing shall be clearly identified on drawings.

8.2.8.9. Pipework and valving shall be configured to allow isolation of local services whilst maintaining adjacent facilities e.g. resilient pipework routing and valve location to ensure that only one Theatre to be off-line at a time, one CCU bed, one renal bed, one standard bed etc..

8.2.8.10. Plumbed in water dispensers shall be provided at ward level and strategic areas including main reception/café areas etc.

8.2.8.11. Plumbed water shall be provided to specialist services such as, but not limited to;

a) Washing machines in specialised units;

b) Catering requirements;

c) Dishwashers in ward areas in accordance with the exemplar layouts and Equipment List; and

d) Retail Units.

8.2.8.12. Plumbed water shall be provided to all vending machines as required throughout The Works in accordance with the Employers Requirements.

8.2.8.13. Attention is drawn in particular to SHTN 02 concerning pipework materials and standards of filtration to be used in Scottish Healthcare Facilities.

8.2.8.14. Cold water system to comply with Hai-Scribe and the Board's infection control requirements.

8.2.8.15. All hand washing facilities to be provided with automatic taps.

8.2.8.16. The Contractor shall carry out a full risk assessment of the complete water systems of the legionella risks and ensure that the system design and equipment selection and installation is carried out to minimise risks.

8.2.8.17. Water shall be provided for fire fighting including sprinklers, wet risers and fire hydrants in accordance with the local authority requirements.

8.2.9. Hot Water Supply

8.2.9.1. Appropriate operational engineering systems for hot water shall be included in the design of The Works.

8.2.9.2. Pipework shall be stainless steel with compatible accessories.

8.2.9.3. Domestic hot water systems shall be designed with plate heat exchangers and buffer vessels to provide adequate flow to satisfy maximum demand whilst minimising stored hot water and energy consumption. The provision of some storage via buffer vessels may be required to minimise the impact of hot water generation on boiler power. (If buffer vessels are required these shall be minimal rating)

8.2.9.4. The adoption of recommended design practices to control of legionella and other bacteria within the systems is critical and is considered mandatory.

8.2.9.5. Type 3 thermostatic mixing valves (TMV's) shall be installed (in accordance with NHS Model Engineering Specification D08) at all HWS outlets to SHTMs and SHGNs except where 60°C water is a particular requirement. Double check valves to be duplicated at TMV's.

8.2.9.6. The Contractor shall carry out a full risk assessment of the complete water systems of the legionella risks and ensure that the system design and equipment selection and installation is carried out to minimise risks.

8.2.9.7. Hot water system to comply with Hai-Scribe and the Board's infection control requirements.

8.2.9.8. Hot water boilers shall be provided in all Staff Rest rooms and Kitchen areas.

8.2.10. Special Water Services

8.2.10.1. The Contractor shall provide all special water services required to support the Employers Requirements, such as but not limited to:-

a) Special supplies such as de-ionised water to specialist Equipment;

b) Special supplies such as de-ionised water to Equipment washers / disinfection Equipment; and

Special supplies for Renal Dialysis (refer to appendix M&E6).

8.2.11. Ventilation & Air Conditioning

8.2.11.1. The heating, ventilation and air conditioning systems shall be logically designed to operate efficiently incorporating heat recovery and provide local control for all areas including single accommodation.

8.2.11.2. The energy and power systems shall be appropriately designed to provide fully integrated designs in terms of the incorporation of engineering services into the building fabric and external spaces.

8.2.11.3. The need to maintain the specified comfort conditions in all areas but particularly in clinical areas is of paramount importance and the Contractor shall develop strategies for achieving the specified environmental conditions with minimum energy consumption.

8.2.11.4. Air Handling Ductwork shall be constructed from galvanised mild steel sheet and not fabricated from any composite board systems. Ductwork shall be manufactured and installed in accordance with DW144.

8.2.11.5. It is essential that the Contractor designs and provides ventilation and air conditioning systems which will ensure occupants comfort. This shall be achieved by use of well tested design principals and suitable plant selection. Air flow problems must be avoided by accurate system balancing, correct selection and location of air diffusers to prevent high air velocities and stratification together with adequate air volumes and accurate temperature control.

8.2.11.6. The Contractor shall comply with the following general criteria for above systems:-

8.2.11.7. Provide natural and mechanical ventilation, comfort cooling, and air conditioning to suit The Works and clinical requirements.

8.2.11.8. Air changes shall be in accordance with CIBSE guides, SHTM's, HTM's and Building Regulations.

8.2.11.9. Provide a climate control facility in clinical and staff areas which are provided with air conditioning (if applicable).

8.2.11.10. Ensure heat gain from all Equipment and personnel is allowed for in sizing and selection of the systems.

8.2.11.11. Demonstrate how their proposals facilitate the control and management of an outbreak and spread of infectious diseases in accordance with SHTM 2025 and SHFN 30 and HAI-SCRIBE. The Contractor demonstration is to cover all aspects of the building, its services, spatial relationships, maintenance regime proposals and incorporate requirements of the Board's Infection Control Team.

8.2.11.12. Ensure that ventilation systems installed in areas classified as hazardous are designed to relevant standards.

8.2.11.13. Where grilles or diffusers are used within rooms the Contractor shall ensure they are:

a) Arranged to avoid draughts;

b) Designed to minimise noise intrusion into the space; and

c) Humidification shall be provided where control of humidity is required for clinical reasons.

8.2.11.14. The Contractor shall provide the resilience requirements of SHPN28 e.g**.** Steam Humidification shall not rely solely on interruptible gas supply.

8.2.11.15. The Contractor shall design the systems set back arrangement in accordance with the requirements of SHPN57 e.g**.** minimum set back temperature in Cardiac CC of 10^{o}C.

8.2.11.16. The Energy Centre shall be adequately ventilated throughout and in compliance with HTM's, SHTN's, CIBSE and Building Regulations current at time of construction.

8.2.11.17. Special consideration shall be given to temperature control and ventilation within transformer rooms, generator rooms, UPS rooms and battery rooms to ensure optimum equipment operation.

Local Exhaust Ventilation Systems

8.2.11.18. The Contractor shall provide all LEV systems including but not limited to that required to support the provision of;

a) Catering;

b) Workshop and maintenance facilities;

c) Plaster rooms;

d) Decontamination suites; and

e) Areas requiring exhaust as noted in SHBN's, SHTN's and SHPN's etc

8.2.12. Fume Cupboard & Micro-biological Safety Cabinets

8.2.12.1. The Contractor shall provide fume cupboard and both CAT II and CAT III microbiological safety cabinet exhaust systems if required to support the Board's Clinical Output Specification, RDS/ADB information. Systems shall comply with NHS Specifications and Guidance documentation which shall include a matched supply system into the room(s) containing fume cupboards and micro-biological safety cabinets. Fume cupboard design and installation shall be to BS 7258. Microbiological Safety Cabinet design and installation shall be to BS 5726.

8.2.13. High Specification Air Conditioning Systems

8.2.13.1. The Contractor shall provide high specification, full function and close control air conditioning systems to support the Board's Clinical Output Specification, such as but not limited to:-

a) Aseptic rooms;

b) Ultra Clean ventilation and / or operating theatres;

c) Pharmacy; and

d) Areas handling radio isotopes or other radiological contaminants.

8.2.13.2. The operating theatre suite within the Adult Acute Hospital shall be provided with five number ultra clean ventilation (UCV) theatres. All other theatres shall be the standard type.

8.2.13.3. This should be verified with the current Architects drawings and Room data Sheets.

8.2.13.4. Each individual operating theatre shall be provided with its own plant, controls and power i.e. One supply and one extract unit, there shall be no sharing of ventilation between the theatre suite.

8.2.13.5. Air conditioning systems installed in the above areas shall be higher specification air conditioning systems with standby motors belted up in accordance with;

a) SHTM 2025;

b) SHTM 2040; and

c) NHS Model Engineering Specification C04.

8.2.14. Ventilation of Isolation Rooms

8.2.14.1. Each 28 bed ward within the Adult Acute Hospital will be provided with a single isolation room.

8.2.14.2. The Children's Hospital will be provided with two isolation rooms per 28 bed ward.

8.2.14.3. This should be verified with the current Architects drawings and Room Data Sheets.

8.2.14.4. The Contractor shall provide air conditioning systems to Isolation Rooms to support;

a) Employers Requirements;

b) Clinical Output Specification; and

c) NHS infection Control standards

With strict positive / negative pressure differentials.

8.2.14.5. A simple to read digital differential pressure gauge shall be provided by the Contractor at the entrance to the isolation suite lobby.

8.2.14.6. Refer to draft SHPN 4 and drawings G1274 M(57)02 & 03.

8.2.14.7. Ventilation and air conditioning systems for these rooms shall be designed and installed in accordance with;

a) SHTM 2025;

b) SHTM 2040;

c) SHPN 4; and

d) NHS Model Engineering Specification C04

8.2.14.8. The Contractor shall demonstrate how their proposals facilitate the control and management of an outbreak and spread of infectious diseases.

8.2.15. ICT Cooling

8.2.15.1. The Contractor shall provide N+1 redundant high specification, full function close control air conditioning systems to support the Board's Technology requirements, such as but not limited to:-

a) Server Rooms;

b) Computer Rooms;

c) Telephone Rooms;

d) CCTV DVR Equipment Rooms; and

e) Entertainment Server Rooms

8.2.15.2. The Contractor shall provide close control cooling systems to support the Board's Technology requirements, such as but not limited to:-

a) ICT Node Rooms;

b) BMS Node rooms (where these are separate from ICT node rooms);

c) Security Node rooms (where these are separate from ICT node rooms); and

d) Entertainment Node rooms (where these are separate from ICT node rooms)

8.2.15.3. No water or condensate generating equipment to be located above racks.

8.2.15.4. All services to be designed to operate on local control from diverse routed automatic change over power supplies to ensure no single point of failure, BMS to monitor plant operation, set points and room environment conditions.

8.2.16. Internal Drainage

8.2.16.1. The Contractor shall provide all necessary drainage to support the Employers Requirements and their aspirations regarding reduced water consumption which shall include but not be limited to:

a) General foul water drainage;

b) General surface water drainage;

c) Kitchen drainage, inclusive of grease traps;

d) Laboratory drainage;

e) Drainage from areas handling radio isotopes, or other contaminants such as silver;

f) Bedpan disposal system; and

g) Harvested rainwater shall not be utilised in clinical areas.

8.2.16.2. The design of the system shall be in accordance with the BS EN 12056 and the Local Authority's Building Inspector's requirements; pipe routing shall be configured to minimize the risk of blockage.

8.2.16.3. Drainage pipework and accessories material shall be selected to suit the appropriate location and type of waste.

8.2.17. Bedhead Services

8.2.17.1. The Contractor shall provide bed head services in line with the ADB sheet requirements together with clinical and operational requirements. The Contractor shall ensure that bedhead services are designed and installed in accordance with SHTM 2015.

8.2.17.2. The units shall be full integrated with the Patient entertainment systems and a dedicated power outlet shall be provided for patient's equipment.

8.2.17.3. The bedhead services shall be provided via high quality proprietary units with integrated lighting and medical gas outlets.

8.2.17.4. Gas Outlets in Children's Hospital to be concealed.

8.2.17.5. The bedhead units at renal locations shall be proprietary type rather than site constructed from standard components provided all in accordance with Appendix M&E6.

8.2.18. CHP Equipment

8.2.18.1. A CHP installation is proposed as part of the low C02 / energy strategy for the new Facilities. The CHP units shall be located within the Energy Centre. The Contractor shall develop the strategy to incorporate the full benefits of tri-generation and select appropriate plant to meet the works requirements.

8.2.18.2. The installation requires to comply with the following general principles;-

a) The system shall be fully integrated with the energy strategy for the new hospital buildings to ensure economical operation;

b) The units shall operate in accordance with the Clean Air Act; and

c) Where biofuels are proposed for the CHP these shall be stored separately from the main fuel storage system and shelf life control regime integrated in the storage facility.

8.2.19. Fire Fighting Systems

8.2.19.1. The Contractor shall provide all fire fighting systems in line with a robust fire strategy for the project as outlined in Volume 2/1 Section 5.11.

8.2.19.2. All elements of the fire fighting systems, such as but not limited to

a) Wet risers;

b) Sprinklers;

c) Gaseous Extinguishants;

d) Fire Hydrants; and

e) Smoke Control Systems etc.

8.2.19.3. The above shall be fully incorporated within the building design at an early date to ensure that all service routes and plant requirements are integrated in the building envelope while maintaining safe, secure access for maintenance and regular system testing of all systems without disturbance to the Clinical operations.

8.2.19.4. Where sprinklers are used special consideration must be given to mitigate infection control issues including risk assessments, water treatment and pre-action systems.

8.2.19.5. All in accordance with (S)HTM 05-01, 05-02 & 05-03.

8.2.19.6. Specialist systems shall be provided by the Contractor for the roof mounted helipad in line with the appropriate standards.

8.2.19.7. Authorised test certificates shall be provided by the Contractor for all life protection systems.

8.2.20. Gas Systems

8.2.20.1. Medical gases

8.2.20.2. The plant shall be rated to accommodate the requirements of the new and retained hospital estate The medical gas pipeline system for the site will require a detailed design package from a specialist consultant including all required co-ordination with existing gas supplies on-site throughout the phasing periods.

8.2.20.3. Contractor to note that detailed design proposals to be discussed and agreed/endorsed with/by Board's Medical Gas Officer.

8.2.20.4. For certification of the works all new developments will require new independent external plant and complete medical gas pipeline systems. The interconnections with the existing and upgraded systems shall be valved off for certification of the main works.

8.2.20.5. The Contractor shall liaise closely with the Boards Supplier who will lease the VIE tanks. The contractor shall carry out all builders work, foundations, bases, blast walls together with all pipe and electrical works

8.2.20.6. The Contractor shall provide all medical gases required to support the Employers Requirements such as but not limited to:-

Oxygen VIE comprising 2 No. Sources (2 fixed manifold rated for the combined load of the new and existing Hospital requirements) (Board provision) Together with connection to existing hospital VIE network and extension of the existing to provide supplies to meet the fall demand requirements of the new works and retained estate;

a) Nitrogen;

b) Nitrous Oxide;

c) Oxygen / Nitrous Oxide mixture;

d) Surgical air 7 bar;

e) Medical air 4 bar;

f) Carbon Dioxide;

g) Helium/Oxygen;

h) Medical Vacuum; and

i) Anaesthetic Gas Scavenging.

8.2.20.7. All medical gas, vacuum, scavenging, and air systems shall be fully maintainable without the requirement to alter other services and a section for each system shall be included in the Contractor's plant replacement strategy detailing the system resilience, redundancy together with the replacement methodology for all vessels, distribution and equipment while maintaining service.

8.2.20.8. All power supplies to medical gas, vacuum, scavenging, and air systems shall be provided from resilient redundant distribution networks with automatic change-overs with

a holistic approach used to minimise disruption to service during electrical testing and maintenance. Isolation and distribution shall be configured to ensure that work on one power stream does not effect other equipment.

8.2.20.9. Medical gas bottles, plant areas and stores shall be accommodated within suitably designed buildings, rooms and enclosures with good access, natural ventilation and satisfactory noise emissions control.

8.2.20.10. All medical gas installations which serve clinical departments shall be connected to essential electrical supplies.

8.2.20.11. The full status of the central medical gas plant shall be monitored by an alarm system with a status signal to an alarm panel located in the FM Control Centre, and local manned office. The panel shall also report the alarm to the BMS.

8.2.20.12. The Contractor shall provide the Medical Gas installation to comply with the following general criteria;

a) Install the piped medical gases in accordance with;

i. SHTM 2022;

ii. (S)HTM 02-01; and

iii. “Model Engineering Specification C11”;

b) Install outlets as required to allow the Clinical operation of each department to be carried out;

c) In accordance with ADB sheets;

d) Within play rooms and recreation rooms all outlets shall be located in lockable area together with masks and flow meters etc;

e) Provide a medical gas distribution system sized to accommodate the demand of The Works as defined in the Room Data Sheets, with the capacity to accommodate an increase in demand (flow and consumption) of no less than 25%;

f) Ensure that the provision of medical gasses to the point of use is continuous. Where the Contractor is providing medical gases via cylinders they shall provide manifold systems with automatic change over from duty to standby to no less than two equal banks of cylinders; and

g) Ensure that adequate points of isolation exist to all medical gas systems in accordance with SHTM 2022, (S)HTM 02-01.

8.2.20.13. The Contractor shall establish duplicate VIE plant compounds within suitable locations to ensure compliance with the Technical Memorandums, Local Approved Person and suppliers requirements. The system shall be rated to accommodate the full site wide requirements and the Contractor shall include for interlinking the new plant with the retained estate systems via valved off interconectors to improve overall site resilience.

8.2.20.14. A ring main will surround the site (NSGH & RHSC) feeding all necessary areas. It will be supplied from primary, secondary and tertiary sources. Compounds shall require an 8m

boundary zone for most activities around the enclosure, going up to 15m for places of assembly and flanges in flammable gas pipes. Allowance should be made for regular large vehicle access for tank refilling.

8.2.21. Medical & Dental Vacuum

8.2.21.1. The Contractor shall provide medical and dental vacuum by duplicate quadruplex vacuum systems each with three pumps and two vessels to provide service as detailed within the relevant ADB Sheets.

8.2.21.2. Medical and dental vacuum plant areas and stores shall be accommodated within suitably designed buildings, rooms and enclosures with good access, natural ventilation and satisfactory noise emissions control.

8.2.21.3. Installations shall be connected to essential electrical supplies.

8.2.21.4. The status of the central medical and dental vacuum plant shall be monitored by an alarm system with a status signal to an alarm panel located in the FM Control Centre, and local manned office. The panel shall also report the alarm to the BMS.

8.2.22. Anaesthetic Gas Scavenging System

8.2.22.1. The Contractor shall provide active AGSS systems in all locations where Nitrous Oxides are used. These shall be duplicate vacuum systems independent of the main vacuum systems.

8.2.22.2. AGSS plant areas and stores shall be accommodated within suitably designed buildings, rooms and enclosures with good access, natural ventilation and satisfactory noise emissions control.

8.2.22.3. The installation shall be connected to essential electrical supplies.

8.2.22.4. The status of the AGSS shall be monitored by an alarm system with a status signal to an alarm panel located in the FM Control Centre, and local manned office. The panel shall also report the alarm to the BMS.

8.2.23. Medical Air

8.2.23.1. Provision of medical air for the New Hospital Buildings would be best provided by duplicate - quadruplex medical air plant, comprising of 4 compressors, 4 dryers and 2 air receivers. It will be located within the Basement plant room area with sufficient air flow for ventilation and cooling of compressors. Each compressor sized for 50% of the design flow – providing the primary and secondary supply. This ensures an N+1 operation allowing full design flow with one compressor out of service. Emergency provision should be an automatic manifold (with cylinders) located within or close to the main building.

8.2.23.2. All supplies will conform to the European Pharmacopoeia standard for controlling air purity, all necessary filters and monitoring systems will be supplied. According to (S)HTM 02, the efficiency of plant, expressed as the volume of air delivered to the pipeline distribution system, a minimum efficiency of 5 m3/kWh at 100% and 10% is required. The power consumption at zero flow should be less than 1% of that at 100% design flow.

8.2.24. Surgical Air

8.2.24.1. The size of the development warrants dedicated duplicate surgical air supply. Surgical air will be provided by a duplex plants, located in each plant room area with sufficient air flow for ventilation and cooling of compressors. An emergency supply from an automatic reserve manifold (with cylinders) will be located in separate accommodation.

8.2.25. Manifold Installations

8.2.25.1. Other gases required throughout the hospital will be supplied by an automatic manifold installation, as in the case of N2O, with an emergency reserve supply connected. Gases used less frequently may be supplied by local cylinders at point of use.

8.2.26. Pneumatic Air Tube Delivery System

8.2.26.1. The Contractor shall provide a pneumatic air tube delivery system as required to the new Facilities to support the Clinical Requirements, as detailed in Appendix M&E7 of the Employers Requirements. The Contractor shall ensure that the pneumatic air transport system shall be designed and installed in accordance with SHTM 2009.

8.2.27. Fuel Storage

8.2.27.1. The Contractor shall provide fuel storage within steel tanks located in the Basement of the Energy Centre. One of the tanks shall be provided early for beneficial use of the Board during the construction works to allow removal of the existing vertical oil tanks. The system shall include, fill points, delivery systems pumps and controls (this facility shall be integrated with the two other tanks to provide a long term fuel management facility for the boards new and retained estate.

8.2.27.2. The following fuels shall be provided by the Contractor and stored:-

a) 35sec Gas Oil - Main Boiler Plant and retained existing estate; and

b) Diesel – Generators.

8.2.27.3. Fill points for the individual fuel types shall be provided by the Contractor at a suitable location on the external wall of the Energy Centre to facilitate automated fuelling from tankers.

8.2.27.4. Supply points shall also be provided by the Contractor for the individual fuel types at a suitable location on the external wall of the Energy Centre to facilitate automated fuel distribution to the site and for tank management.

8.2.27.5. The quantity of oil storage shall be in compliance with the requirements of Appendix M&E2 Paragraph 3.0.

8.2.27.6. All plant and equipment and installations shall be in accordance with the HTM's, SHTM's and National Health Service Model Engineering Specifications with amendments to the Model Engineering Specifications to meet the requirements of the HTM's and SHTM's.

8.2.28. Testing and Commissioning of Mechanical Services

8.2.28.1. All Buildings, Services and Equipment shall be commissioned by The Contractor to ensure that they are all compliant with the quality and performance specifications,

including manufacturer's recommendations, and that all systems operate to the Board's satisfaction.

8.2.28.2. The Contractor shall appoint an independent Commissioning Engineer to manage the Testing and Commissioning as detailed in Appendix M&E3

8.2.28.3. The Contractor shall as a minimum commission the works in accordance with the 'Guidance to Engineering Commissioning' published by The Institute of Hospital Engineers (1995).

8.2.28.4. The Contractor shall be responsible for demonstrating and certifying to the Board the successful completion of all commissioning, testing and compliance with all relevant standards.

8.2.28.5. The Contractor shall provide a comprehensive hard and soft copy sets of Operations and Maintenance Manuals together with the MiCAD as fitted drawings (hard and electronic) for all installed and commissioned Equipment. 3 number off sets of each to be provided.

8.2.29. Connection to Specialist equipment

8.2.29.1. The Contractor shall include for final connection of all specialist clinical equipment including MRI's Xray, Imaging, Theatre, CCU and general equipment as indicated in the Board's Equipment Schedules.

8.2.29.2. The main services shall be terminated within 1m of each piece of equipment with the final connection being carried out in conjunction with the equipment supplier.

8.2.29.3. Energy for all Board equipment shall be supplied from the most efficient source e.g. MTHW for dishwashers etc.

8.2.29.4. All terminations shall be in accordance with the manufacturers written recommendations.

8.2.30. Water Services Leak Detection

8.2.30.1. The Contractor shall provide leak detection to all external water mains and transfer pipework serving the satellite tanks located within the basements of the other buildings by means of pressure switches and interconnecting controls to provide an audible and visual alarm in the event of major leakage and provide alarm signals at the BMS front end within the FM Control Centre.

8.2.30.2. Leak detection shall also be provided by the Contractor at:

a) Perimeter of all ICT Server rooms;

b) Perimeter of all ICT Node rooms;

c) Plant room bunds adjacent to theatres, radiology and critical care areas; and

d) Tunnel sumps.

8.2.30.3. These shall provide an audible and visual alarm in the event of local leakage and provide alarm signals at the BMS front end within the FM Control Centre.

8.2.31. Smoke Control

8.2.31.1. The Contractor shall provide all Smoke Control and Smoke Extract systems and equipment to meet the agreed fire strategy for the hospital developments. All in accordance with (S)HTM 05-01, 05-02 & 05-03.

8.2.32. Stair pressurisation

8.2.32.1. The Contractor shall provide as required Stair Pressurisation systems and equipment to meet the agreed fire strategy for the hospital developments. All in accordance with (S)HTM 05-01, 05-02 & 05-03.

SECTION 8.3 - ELECTRICAL

8.3.1. General

8.3.1.1. The Contractor shall design, supply, install, test, commission and put into service all Electrical Building Services necessary to support the clinical activities of The Works. The following systems are indicative of those anticipated by the Board but are not exhaustive and it shall be the Contractor's sole responsibility to determine that all necessary systems (excluding Medical Equipment) are included.

8.3.1.2. Systems shall be designed, supplied, installed, tested, commissioned and put into service all in accordance with the relevant Regulations and Standards.

8.3.2. Electrical Distribution Systems

8.3.2.1. MV Systems

8.3.2.1.1 A new Primary Sub- Station shall be established within the Southern General Site, discussions have taken place with Scottish Power. The Contractor shall conclude these negotiations and include for all works associated with the Construction of the Primary Sub-Station.

8.3.2.1.2 Refer to Appendix M&E1 for Utility correspondence.

8.3.2.1.3 The new Primary Sub-station shall incorporate a composite Client/Utility Company outgoing 11kV switchboard; the switchboard shall be configured to meet Scottish Power Requirements together with metered outgoing ways to allow:

a) Two ring mains to be provided for the new Hospital system being designed by the Contractor; and

b) Two further ring mains for the Board's future configuration of the retained and future estates requirements.

8.3.2.1.4 Automatic protection shall be provided to route power through the rings to minimise downtime on all unaffected sub-stations after a cable or sub-station fault.

8.3.2.1.5 Distribution in relation to the Works is to consist of separate closed unit protected auto-switching ring mains dedicated to each hospital. Unit protection shall be by pilot cables and time graded relays.

8.3.2.1.6 A full instrumentation and protection system with multi-function meters, over-current and earth fault protection to the primary ring mains shall be provided complete with remote monitoring via the BMS and FM Control Centre.

8.3.2.1.7 Refer to drawing G1274E(60)01 for indicative schematic.

8.3.2.1.8 The new Primary Sub-Station shall be delivered to allow power to be made available in line with the Laboratory Practical Completion date. Refer to Volume 2.2 documentation for details of fall back scenario if this cannot be accommodated.

8.3.2.2. LV Systems

8.3.2.2.1 All wiring systems shall be of a form defined within BS 7671:2008 (IEE Wiring Regulations 17th Edition).

8.3.2.2.2 Main LV switchgear shall comprise metal cubicle pattern switchgear enclosures containing Air Circuit Breakers (ACB) and Moulded Case Circuit Breakers (MCCB) with electronic protection selected to allow short circuit, over-current and time grading for full co-ordination and discrimination.

8.3.2.2.3 Each LV section shall be fitted with automatic power factor correction to correct the local power factor to no less than 0.95, the correction equipment shall be located closed to the corrected load, with hard wired automatic drop out facility during generator run and reset on return to mains.

8.3.2.2.4 All ACB's and main distribution ACCB's shall be fitted with monitoring units to capture and relay switchgear status, energy consumption. harmonic content, operation counter and fault indication via the Central Power Monitoring System

8.3.2.2.5 The Central Power Monitoring System work-station shall be located within the main FM control room with a second work-station located in the Estates Office.

8.3.2.2.6 The Central Power Monitoring System shall provide hierarchical maps indicating active mimic of the complete power and stand-by power distribution systems.

8.3.2.2.7 Each Main Switchboard shall be fitted with a touch screen PC to provide access to the maps and interactive mimic screens.

8.3.2.2.8 A hard copy cellular wall mounted MV Mimic Diagram shall be provided by the Contractor in the Estates Office to allow system status to be recorded manually.

8.3.2.2.9 All main LV switchboards shall be constructed to Form 4 Type 6.

8.3.2.2.10 Sub distribution and final distribution boards shall be constructed to:

a) Form 4 Type 2 for Clinical Risk Categories 1 & 2; and

b) Form 4 Type 6 for Clinical Risk Categories 3, 4 & 5

8.3.2.2.11 Risk Categories determined as (S)HTM 06-01

8.3.2.2.12 For the Works, most of the areas fall into Clinical Risk Categories 3, 4 & 5. Robust electrical supplies shall be provided to serve:

a) General lighting;

b) Standby lighting;

c) General power;

d) Medical power;

e) Medical IPS power;

f) Mechanical services plant (ventilation, medical gases, water, chilled water etc); and

g) ICT Power

8.3.2.2.13 The tower of the Adult Acute hospital contains general ward areas. For the avoidance of doubt the Board require Building Services for the Wards appropriate to Clinical Risk Category 3.

8.3.2.2.14 Due to the adjacencies, dual transformers and switch panels shall be provided to form part of the dual-unified supply philosophy employed in the distribution design. Like the MV distribution, the LV distribution shall be divided into Side A and Side B circuits. Side A and Side B Main LV switch panels adjacent to transformer substations and separate compartments will be linked together via an automatic `*bus-coupler-bus-tie'* cable way and two ACB's.

8.3.2.2.15 A robust arrangement, shall be provided to ensure that a fault or problem on the Side A switch panel does not affect the Side B panel and vice versa.

8.3.2.2.16 The Contractor shall integrate the distributed transformers, main and secondary low voltage switch rooms within the development to suit the final layout while minimising cable losses and providing simple maintenance / replacement access.

8.3.2.2.17 All plant rooms are to be in accordance with (S)HTM 2023 and (S)HTM-06-01 and the contractor shall provide a detailed Plant Replacement Strategy.

8.3.2.2.18 Distribution of LV power within the tower will be by three-phase bus-bar ducting with full size phase, neutral and earth conductors. Multiple tap off units shall be provided at each floor to serve distribution boards for lighting and power together with 25% spare capacity.

8.3.2.2.19 Each tap off unit shall contain a circuit breaker to provide full electronic time graded fault protection. The energy monitoring strategy may incorporate meters within the tap off units however where split distribution boards are proposed multiple meters shall be incorporated in the split distribution boards. All meters shall be linked back to the central system to allow remote load monitoring and energy management.

8.3.2.2.20 Each rising bus-bar pair shall serve each of the 'wings' of the tower. In accordance with the dual-unified distribution, each bus-bar pair shall comprise separate Side A and Side B bus-bars rising through the building in separate risers.

8.3.2.2.21 The final solution shall provide full system resilience and allow the distribution equipment to be maintained with the minimum of disruption to services at ward and departmental level.

8.3.2.2.22 Final circuit distribution boards shall be Type A or B with miniature circuit breaker (MCB) and (RCBO's) boards to BS EN 60439-3 located within risers or dedicated cupboards. All distribution boards are to be lockable with a suited key system with sheet metal doors to prevent unauthorised access. All boards shall be provided with ASTA certified bus-bars (rated to suit the local prospective fault current) neutral and earth terminals for each single phase way, clean earth facilities, extension spreader boxes for incoming cables separate CPC's, RCBO connections and flexible split metering facilities.

8.3.2.2.23 Distribution boards with plastic enclosures must not be used.

8.3.2.2.24 Power for all Mechanical, Public Health and Specialist systems shall be provided with resilience and redundancy to allow maintenance to be carried out on specific plant and distribution paths without the requirement to take other plant out of service.

8.3.2.2.25 All power circuits to be sized in accordance with BS7671.

8.3.2.2.26 Switchgear, Control panels etc, shall be securely located in plant areas and distribution cupboards not able to be accessed by public, patients or non FM staff.

8.3.2.3. Cables and Containment

8.3.2.3.1 Primary LV sub-main distribution is to be by bus-ducts, bus-bars and multi-core XLPE/SWA/LSF (low smoke & fume) cables to BS6724 carried on ladder rack (larger cables) and/or cable tray/basket (smaller cables). Primary LV cabling and containment is to be concealed within dedicated risers, cable trenches and risers throughout the building.

8.3.2.3.2 Side A and Side B cables and containment will be segregated and run by different routes to the final outlet as far as practicable, this requires Side A and Side B final circuit cabling to be run in separate containment up to bed head trunking units.

8.3.3. Lighting and Power

8.3.3.1. Interior Lighting

8.3.3.1.1 The lighting design must be functional for clinical use in accordance with the CIBSE and Society of Light and Lighting guides together with relevant SHTM's, SHBN's etc., the Contractor shall also ensure that the overall lighting concept is co-ordinated with the building structure and the project aesthetic requirements. Particular attention is required within entrance, circulation and non clinical areas where a mixture of LED's, conventional low energy fittings and retail lighting techniques shall be utilised to enhance the internal and external building experience in line with the architectural intent.

8.3.3.1.2 Where high efficient fluorescent lamps are not appropriate e.g. for aesthetics, signage and lighting of art works etc, the use of high output LED units and compact discharge sources shall be selected in lieu of tungsten lamps.

8.3.3.1.3 The Contractor shall provide and install high efficiency luminaires, utilising high frequency electronic control gear to provide occupiers with improved visual comfort while reducing noise levels and running costs.

8.3.3.1.4 Where VDU's are being used, the Contractor shall ensure that the lighting scheme complies with "CIBSE Lighting Guide LG3 and LG7.

8.3.3.1.5 The Contractor shall ensure that corridor lighting is multi circuited to facilitate use of 100% or 50% of the luminaires. Where the corridor is over 15 metres in length interlaced zoned lighting shall be provided. This resilient strategy must be imposed on the lighting control system design to ensure that lighting in each area is partially retained in use during maintenance of the alternate area distribution board and alternate section of the lighting control system.

8.3.3.1.6 Night lighting shall be provided within all corridors either by individual fittings or by selective switching of the general corridor wall/ceiling luminaires. The Contractor shall ensure night lighting in corridors shall not spill into patient bedrooms, or other bedded areas. Night lighting shall be provided at nurse stations, patient bed areas and locations where call systems are installed.

8.3.3.1.7 Ward night lighting override control to be fitted at nurse stations.

8.3.3.1.8 Luminaires shall be located to provide ready access for lamp changing and maintenance, whilst still providing the recommended level and quality of illumination to the area.

8.3.3.1.9 All signage is to be illuminated to ensure ease of legibility without causing glare.

8.3.3.1.10 Where sealed fittings are required e.g. in treatment rooms, isolation suites, theatres etc. the diffusers shall be composite type with easy clean flat surfaces with the optics incorporated within a stable sandwich construction.

8.3.3.1.11 Treatment Room luminaires which provide the general lighting shall be controlled by at least two circuits depending on the arrangement of fluorescent tubes in each fitting. The design of these luminaires must provide ease of access for lamp changing.

8.3.3.1.12 In ward areas the lighting shall be integrated with the bedhead services solution with combination wall mounted dimmer controlled fittings providing patient rest, watch light, reading light and examination facilities.

8.3.3.1.13 Where bed areas are used for intervention and treatment an overhead lighting scheme supplemented by bedhead units providing patient rest, watch light, reading light and examination facilities shall be provided.

8.3.3.1.14 Light fittings shall not be mounted immediately above patient positions.

8.3.3.1.15 All fluorescent lamps used in clinical areas shall have as a minimum a colour rendering capability of ≥ 85 CRI. For practical reasons consideration should be given by the Contractor to using the same luminaire in both Clinical and Non-Clinical spaces within the same ward. A reading light with an on/off switch shall be provided at each bedhead location and at the door. The Contractor shall provide an additional switch on the nurse call handset.

8.3.3.1.16 Where luminaires of the fully recessed type (modular and / or downlighter) are installed within fire rated ceilings, they should be provided with a one hour rated fire canopy. The Contractor shall also ensure that they maintain the integrity of the ceiling and that the canopies are tested to “BS 476 Parts 20 and 23, clause 5. The Contractor shall also ensure that all canopies meet the requirements of “Class O materials”.

8.3.3.1.17 Hazardous areas shall be provided by the Contractor with the appropriate classified luminaries.

8.3.3.1.18 Luminaires with prismatic diffusers installed on fire escape routes shall be fitted with flame retardant diffusers to TP (a) classification, minimum Class 3 surface spread of flame.

8.3.3.1.19 Each high dependency and recovery bed position shall have a wall or bed-head trunking mounted, examination lamp with integral switch.

8.3.3.1.20 Sealed food factory type luminaires shall be provided by the Contractor in areas in which food is prepared, cooked and stored.

8.3.3.1.21 Accessible plant areas, roof void areas, ducts, lift motor rooms, shafts and similar utility areas shall be illuminated utilising suitably IP rated luminaires.

8.3.3.1.22 Over-mirror lights shall be provided by the Contractor in all en-suites, shower rooms bathrooms and in all Male and Female changing rooms.

8.3.3.1.23 Lighting in toilets accessible to the public shall be fitted with blue light effect to minimise unsocial activities.

8.3.3.1.24 Laser and x-ray warning lights shall be provided by the Contractor outside theatres, major treatment rooms and x-ray rooms interfaced with the laser / x-ray machines.

8.3.3.1.25 Lighting levels to be in accordance with CIBSE guides and SHPN's. Theatre Pendants and lights to be selected by Board. Contractor to allow for all services.

8.3.3.2. Lighting Control & Wiring

8.3.3.2.1 The Contractor shall provide automatic control of lighting using natural light level sensing and the BMS scheduling capability for unoccupied periods (with movement sensing override for safety) primarily in circulation areas and large open workspaces.

8.3.3.2.2 In plant rooms additional controls interfaced with the access control system shall be provided at main plant room entrances to override the automatic off signals, allowing staff to carry out inspection and maintenance outwith the normal reach of the presence detection system.

8.3.3.2.3 The Contractor shall ensure that the lighting design incorporates a flexible switching arrangement to allow for varying activities within each room and for cleaning purposes. Switches for all public areas should be positioned by the Contractor so that unauthorised persons cannot switch the lighting.

8.3.3.2.4 Lighting within all WC's, Staff WC's and changing rooms shall be controlled via passive infrared sensors/movement detectors or similar, with adjustable time control facilities.

8.3.3.2.5 Lighting within clinical areas shall incorporate manual override controls

8.3.3.2.6 The Contractor shall arrange the circuiting of luminaires to control groups of fittings in order to provide flexibility of switching arrangements. Such a facility is particularly

important in large spaces where the level of daylight is not uniform and artificial lighting is likely to be needed for long period in areas remote from windows.

8.3.3.2.7 The Contractor shall provide the luminaire isolation requirements of SHPN57 e.g. all luminaires to be provided with means of safe isolation to prevent isolation of adjacent fittings for replacement.

8.3.3.2.8 The Contractor shall provide alternative circuits together with two-way or intermediate switching at all section doors and corridor direction changes for lighting in corridors and circulation areas.

8.3.3.2.9 Where multi-gang lighting control switches are required the Contractor shall provide a label fixed to the grid under the switch plate, indicating the switches are fed from different supplies.

8.3.3.2.10 The Contractor shall provide the Lighting requirements of SHPN57 e.g. all lighting in Critical Care Areas shall be dimmable with local controls. (This is in addition to the general requirement for dimmable lighting which shall be provided throughout for the purpose of energy control and commissioning setting).

8.3.3.2.11 All small power accessories and Isolation devices shall be engraved with the accessory function.

8.3.3.2.12 Circuit designation labels shall be provided at all electrical accessories.

8.3.3.2.13 All power cables shall be provided with circuit references adjacent to terminations, the references shall be co-ordinated with the MiCAD As Fitted drawings and asset register tags.

8.3.3.3. Emergency Lighting

8.3.3.3.1 The Contractor shall connect the emergency lighting to addressable self-monitoring control panels with each luminaire containing an interface unit that shall be monitored and controlled by the control panel which shall report to the BMS system. The Contractor shall demonstrate that the emergency luminaires are automatically tested in accordance with the requirements of the British Standards.

8.3.3.3.2 Local circuit monitoring shall be provided to protect all areas.

8.3.3.3.3 The emergency luminaires may be of either the maintained or non-maintained variety. The Contractor shall ensure that they are powered by a suitable battery supply connected by an auto-changeover switch or utilise self-contained battery packs within luminaires (3-hour rated). The Contractor shall ensure that the emergency luminaires will be automatically energised in the event of a failure to the local lighting circuit.

8.3.3.3.4 The Emergency Lighting shall comply with BS5266 and (S)HTM2011.

Standby Lighting

8.3.3.4.1 The Contractor shall provide 100% standby lighting via the site generation system to enable normal activities to continue during the loss of a normal mains supply.

8.3.3.4.2 The Contractor shall ensure that the quality of standby lighting is equal to that of the normal lighting at the task points.

8.3.3.5. Wiring

8.3.3.5.1 Wiring will be generally be carried out using LSF insulated single cables run in concealed steel conduit and trunking. Connections to all suspended ceiling mounted fluorescent luminaires and non modular lights shall be made via a plug & socket/ lighting control module arrangement and a reasonable length of flexible heat resisting sheathed cable. Flexible cables shall not be trailed across the top of ceiling grids.

8.3.3.5.2 Modular wiring systems may be considered for lighting in non clinical areas, however if these are put forward the components must be sturdy, proven in use with long lifespan.

8.3.3.5.3 Loop In system in metal conduit to be utilised for wiring in areas with fixed ceilings.

8.3.3.6 Small Power

8.3.3.6.1 Where required small power circuits shall be provided in accordance with the MEIGaN.

8.3.3.6.2 Where required small power circuits shall be provided from Insulated Power Supplies.

8.3.3.6.3 Where required small power circuits shall be provided from Uninterruptible Power Supplies (UPS).Final circuits shall be interlaced fed from either side of the dual power distribution systems.

8.3.3.6.4 All clinical circuits shall be wired in metal conduit and containment.

8.3.3.6.5 Power shall be provided at docking stations for recharge of robotic units.

8.3.3.6.6 The Contractor shall provide the small power requirements of SHPN57 e.g. via ceiling mounted medical supply units rather than wall mounted outlets in Critical Care Areas.

8.3.3.6.7 The Contractor shall provide the power requirements of SHPN28 e.g. All Theatres shall be provided with two articulated pendants

8.3.3.7 External Lighting

8.3.3.7.1 The perimeter, including all entrance canopies and pedestrian walkways, to all buildings shall be lit by the use of energy efficient luminaires mounted in canopies, on walls, columns and/or bollards. All on-site access roads, service yards and areas, footpaths and cycle ways shall be lit to levels compatible with the GCC Highway standards. The lighting shall satisfy the requirements of BS 5489. Lighting shall be provided by the Contractor to all direction signs around the Site where these are not adequately illuminated by external lighting.

8.3.3.7.2 The system shall also provide a welcoming atmosphere to the main entrances.

8.3.3.7.3 All access routes to plant areas shall be lit to provide safe access for maintenance.

8.3.3.7.4 All wall mounted luminaries shall be fed by back entry. Cable runs on the outside of buildings shall not be permitted.

8.3.3.7.5 All external columns, bollards etc. shall be provided with fused cut-outs and adequate termination facilities for cabling.

8.3.3.7.6 When selecting luminaires, the Contractor shall give consideration to light pollution, vandalism, security, energy efficiency and local residents. The Contractor shall ensure that the installed scheme meets the requirements of the Civil Airport Authority (CAA).

8.3.3.7.7 The Contractor shall provide warning lighting on the main building and flue in accordance with the CAA requirements.

8.3.3.7.8 The Contractor shall provide helipad lighting in accordance with the CAA requirements and the Hospital Guides.

8.3.3.7.9 The BMS shall control external lighting to minimise energy consumption, by photocell or movement sensor, the lamp type selected must be sympathetic to frequency of switching dictated by the control means.

8.3.3.7.10 The Contractor shall utilise solar powered lighting where this can be shown to be effective on the site over a reasonable time period; these shall be supplemented by conventional luminaires when the output is not available.

8.3.3.7.11 The Contractor shall wire luminaires on multiple circuits to avoid loss of light to whole areas in the event of a maintenance and mains/circuit failure.

8.3.3.7.12 External lighting installations shall be designed to provide safe lighting levels in accordance with CIBSE guides and “Secure by Design” requirements.

8.3.3.7.13 Back-up floodlighting shall be provided from FM building into yard and buildings onto entrances pathways and roads should the ‘Contractors Street Lighting’ fail.

8.3.4 Fire Alarm and Detection Systems

8.3.4.1 The Contractor shall ensure that the fully addressable automatic fire detection system integrated within the BMS for The Works is fully compliant with the performance criteria laid down under (S)HTM05 and BS 5839. Refer to Fire Strategy Volume 2.1 Paragraph 5.11.

8.3.4.2 The systems are to be designed to BS 5839 category L1 and are generally to be analogue addressable with aspirated detection provided in areas including Theatres, X-ray, MRI, and ICT rooms and all other 'specialist suites'.

8.3.4.3 All aspirating air sampling units shall be located away from public areas, either in service cupboards or accessible services risers. All circulation doors shall be installed with integrated electro magnetic door hold open devices with all security door locks interlocked for evacuation in a zoned fire condition. The locks and hold open devices must not reduce the rated fire integrity of the doors.

8.3.4.4 The aspirated systems shall be capable of providing identification of alarms or faults within individual sampling pipes.

8.3.4.5 The system design shall be integrated with the requirements of the clinical requirements.

8.3.4.6 A Fire Control Station shall be set up within the new FM Building providing command and control for the life safety systems including PC Graphics for:

a) Fire Alarm Detection and annunciation;

b) Sprinklers (monitoring);

c) Smoke dampers (monitoring and control);

d) Fire fighting systems (monitoring and control);

e) Stair pressurisation (monitoring and control);

f) Helipad systems (monitoring);

g) Cold smoke extract (monitoring and control); and

h) All systems provided in accordance with the agreed fire strategy.

8.3.4.7 The Contractor shall liaise closely with the following;

a) Board's Fire Officer;

b) Glasgow City Council; and

c) Strathclyde Fire Brigade

and ensure that an agreed fire alarm cause and effect matrix is provided by the Contractor prior to detailed design to ensure that the systems support the overall fire strategy.

8.3.4.8 Control panels are to be provided in the Control Room and at the main entrances (or at the entrances to which the fire service are to attend, if different), with additional indicator panels provided throughout the building to allow staff to respond in accordance with local evacuation procedures, and to guide the fire service to the source of the alarm.

8.3.4.9 The control panels shall be fully networked with resilient connections to the site based PC font end with map facilities and remote graphics monitoring in Hillington via a dedicated link.

8.3.4.10 The system shall be equipped with sufficient sounders to maintain sound outputs in different areas in accordance with (S)HTM 05, and incorporate visual strobe indicators for a fire condition in accordance with the requirements of the Disability Discrimination Act.

8.3.4.11 The Contractor shall ensure that The Works are divided into zones by ward / department / unit area as well as by floors with mimic or repeater panels at each nurse station (or equivalent) and at least one panel per floor located in a central circulation area. In the event of fire The Works shall be capable of individual zone evacuation with all other zones receiving awareness signalling.

8.3.4.12 The Contractor shall ensure that all fire alarm panels are capable of giving details of system status for fire, fault, and alarm conditions including full text descriptions of location at all nodes and staff base positions.

8.3.4.13 All panels shall be capable of data / event logging and report generation.

8.3.4.14 Manual call points must be provided at every exit and staircase with no point in the building being more than 30m travel from a call device.

8.3.4.15 Fire Alarm Evacuation facilities shall be provided at each main node, these shall require a double action e.g. break frangible lid and then break glass unit.

8.3.4.16 Materials and equipment shall be the catalogued products of manufacturers regularly engaged in production and installation of automatic fire detection systems and shall be manufacturer's latest standard design that complies with the relevant Standards and Regulations.

8.3.4.17 The Contractor shall ensure, and provide necessary documentation to confirm that this system will have a documented history of compatibility by design for a minimum of 15 years. Future compatibility shall be supported for no less than 10 years. Compatibility shall be defined as the ability to upgrade existing systems to current level of technology, and extend new field panels on a previously installed network.

8.3.4.18 The Contractor shall take into account the need for maintaining patient security during alarm testing i.e. the testing regime shall not allow for ordinarily secure doors to open as a result of routine testing.

8.3.4.19 The Contractor to provide fire suppression systems in line with the proposed fire strategy, which shall include provision of gaseous systems in ICT rooms and Electrical Sub-stations together with the special requirements for the Helipad.

8.3.4.20 The Contractor shall provide fire hydrants to meet the Glasgow Council’s Building Control Department and Strathclyde Fire Brigade requirements.

8.3.4.21 Progressive horizontal evacuation in patient areas is to be facilitated by each fire resisting sub-compartment being on a separate alarm zone, and by the use of two stage (evacuate/ alert) alarms. To avoid unnecessary disturbance, staff elsewhere in the building who are required to perform particular tasks in the event of a fire are to be automatically alerted by pagers or electronic communications devices to avoid the sounding of the fire alarm.

8.3.4.22 In areas where patients can escape unaided and in non-patient areas the audibility of the fire alarm should be in accordance with BS 5839. However, in other areas an audible alarm may be unacceptable and the use of visual devices is to be provided in areas such as very high dependency patient areas, these include operating theatres, ITU, audiology, plant areas, service yards, imaging and areas with high ambient noise etc.

8.3.4.23 The fire alarm signal is to be transmitted automatically to an alarm receiving centre via a monitored line to supplement the control room operation.

8.3.4.24 The fire alarm system is to contain links to all necessary ancillary services such as;

a) Automatic Door Releases;

b) Door Control Systems;

c) Access Control Systems;

d) Ventilation Systems;

e) Lifts etc; and

f) Robotics

8.3.4.25 All wiring to be MICC with red LSF sheath.

8.3.5 Telephone Distribution Systems

8.3.5.1 The Hospital requires efficient, high quality telecommunications service provided to both its internal and external customers on a 24-hour basis. The Contractor will provide a robust resilient high quality cabling infrastructure, with appropriately selected switches provided by the Hospital.

8.3.5.2 Cable links with existing Telephone equipment throughout the site will be required, with all necessary underground ducts together with copper and blown fibre provided by the Contractor.

8.3.5.3 Mobility will be covered with wireless handsets on the IP network.

8.3.5.4 Analogue line facility to be provided for faxes rather than VoIP.

8.3.5.5 10% fall back lines to be provided by the Contractor throughout the works, present technology is for PABX and analogue phones. (PABX by the Hospital, This may be simplified by technology improvement but allow analogue distribution in the meantime).

8.3.5.6 The Contractor shall supply onsite paging facilities for the works to meet the standards provided by the current service provider Multitone Electronics plc, Unit 33 Geddes House, Kirkton North, Livingston, West Lothian, EH54 6GU. Space to be allocated in node rooms for Multitone paging equipment.

8.3.5.7 New Aerial/s to be provided to ensure full coverage throughout the works.

8.3.5.8 Emergency Voice patching to be colour co-ordinated (grey).

8.3.5.9 Field cabling racks and cabling to be set up for Power over Ethernet to minimise requirement for power plugs at feature phones.

8.3.5.10 Payphones will be provided under the current managed service Premier Telesolutions, 10 Alexandra Way, Ashchurch Business Centre, Tewksbury, Gloucestershire, GL20 8NB. The contractor shall provide telephone outlets and power at required areas and the managed payphone company shall provide the hardware and service. Space to be provided for node cabinet etc.

8.3.5.11 A separate Comms room and Office shall be provided for the patient telephone lease company to accommodate their switch and billing units,

8.3.5.12 The Contractor shall include for Analogue lines to be provided for all remotely monitored systems including: Cardiac, Fire, Lifts, VIE, BMS, etc. and for all systems provided by the Contractor.

8.3.5.13 Lift cars to have two comms connections, one for remote monitoring of performance and one for interlinking to the Hillington Control Centre.

8.3.5.14 GEMS to be provided with dedicated incoming lines for their network and telephone switch equipment.

8.3.5.15 Contractor to include 6 ducts from each main server room to the main hospital boundary for Voice/Data Use to suit the agreed communications vendors.

8.3.5.16 Contractor to include 2 ducts from each main server room to the Laboratories.

8.3.5.17 Contractor to include 2 ducts from each main server room to the Estates Department.

8.3.6 Information Technology (IT) Equipment and Distribution Systems

8.3.6.1 Overall Requirements.

8.3.6.1.1 The Board recognises the importance of information and communication in all aspects of its work; improved communication enables improved efficiency.

8.3.6.1.2 The continued development of technologies provides an increased potential to simplify systems and reduce duplication allowing the Board a more complex management system of greater value to users and the Board itself.

8.3.6.1.3 This specification is intended to co-ordinate the various aspects of communication systems within the Board's operations. The specification does not describe all individual systems and their operation in great detail, but identifies the various communication systems, the Board's current strategies for their development and maintenance, the obligations placed on the Contractor.

8.3.6.2 The Contractor shall design, construct and put into service a comprehensive and robust infrastructure (e.g. containment, cabling, power, A/C, Racks, raised floors, floor grills, comms rooms and server rooms) for The Works in accordance with the requirements of the Board's Requirements.

8.3.6.3 The infrastructure shall be commissioned, labelled and documented prior to handover to the Board.

The Board will install hardware (e.g. servers, comms hardware, PCs, printers, scanners), make the final connections (at the application and in computer rooms) and commission the operational system.

8.3.6.4 The Contractor shall provide only those systems that are fully compatible with the Board's operational Information Technology systems.

8.3.6.5 The Works will be served by an N+1 server room distribution. These shall be provided internally within the new development. The server rooms should have dedicated air conditioning, fire suppression, generator back up with diverse routed power and redundant UPS systems to maintain resilience in the IT network.

8.3.6.6 The 2 main comms rooms will house servers for local distribution whilst providing diverse links with existing comms rooms throughout the Hospital estate and further a field. The Contractor shall design each room to accommodate 6 comms racks, 10 server racks and 10 equipment racks, sufficient racks for the Contractors field cabling together with sufficient racks for the Contractors BMS, CCTV, and Entertainment equipment etc. together with space provision for access round racks and work bench laptop space. All racks to be provided by the Contractor, racks are to be lockable with a suited key system for Voice, Data, combined Voice and Data, CCTV, BMS etc.

8.3.6.7 Within these principal ICT rooms, telephony servers will be provided by the hospital.

8.3.6.8 As above multiple racks shall be provided by the Contractor allowing sufficient space for network expansion. Racks shall be 42U, 800mm x 1000mm (space for 1200mm) suitable for high velocity through ventilation based on hot/cold isle philosophy.

8.3.6.9 Data risers shall be established to interlink the main server and hub rooms, the risers shall be of sufficient size to accommodate 25% network expansion and modification.

8.3.6.10 The Contractor shall provide the requisite number of hubs to suit their proposed building layout to ensure compliance with the cable length restrictions. Hubs shall be sized to accommodate all of the Contractors Equipment together with a 42U rack dedicated for the Board's use.

8.3.6.11 It is envisaged that the Board will be using voice over IP for telephony.

8.3.6.12 It is envisaged that the Board will be using wireless technology (RFID) for public, staff data, patient monitoring, equipment tracking and automated transfer system connections, access points shall be provided by the Contractor throughout the facility to meet these onerous demands. The access points shall be located to meet the various system demands throughout all areas of the works. The Contractor shall provide a robust system with area coverage overlap and resilient interconnection to the network suitable for supporting the full RFID requirements.

8.3.6.13 The Contractor shall ensure that the lighting in all ICT rooms is sufficient to allow for safe working on plant and equipment. No water, steam or waste services shall be located either in or directly above the ICT room due to risk of water damage.

8.3.6.14 Infrastructure provided by the Contractor shall be fully compliant with the requirements of the NHSIA N3 project.

8.3.6.15 The Infrastructure shall provide the Connectivity requirements of SHPN57 e.g. Wide bandwidth service etc.

8.3.6.16 The Infrastructure shall provide the Connectivity requirements of SHPN28 e.g. all theatres to be provided with cabling to theatre lights to allow for camera connection to seminar room and general telemedicine system, refer to section 8.1.34 for Telemedicine details.

8.3.7 ICT Workshop

8.3.7.1 The ICT staff workshop shall be provided adjacent to each server room; the workshop shall have suitable environment and services to allow equipment to be tested.

8.3.8 Wireless Networks

8.3.8.1 The Contractor shall provide a secure wireless network which supports the Board's requirements as set out below:

8.3.9 External Services (WAN)

8.3.9.1 As noted above multiple ducts shall be provided by the Contractor from the network vendors external access points (ducts) to each of the Server rooms. These shall be of a size suitable for external grade fibre cable(s), and copper multi-core cable(s).Further ducts will be required providing links to existing building within the estate. The Contractor shall ensure that the Board is granted free access to these ducts at all times so that it may access communications services from any third party it wishes to nominate.

8.3.10 Cabling

8.3.10.1 Cabling systems shall be installed to the highest ratified specification for IT wiring systems as defined in EN50173 and EN 50173 or equivalent standard.

8.3.10.2 All Fibres are to be single mode blown type, mesh star configuration with minimum of 20 pairs backbone.

8.3.10.3 The Contractor shall demonstrate that the proposed copper structured cable is suitable for the latest available known technology at the time of tender and be as a minimum CAT6 Augmented.

8.3.10.4 The jacket construction of the cable must be suitable for the application and details must be provided in the tender. The installation shall also cater for two outlets at every workstation being able to support a VoIP installation in line with the agreed schedules.

8.3.10.5 All voice cabling installed shall allow for an agreed spare capacity over and above the spare requirements stated in the general section.

8.3.10.6 Cables, which pass through the infrastructure of the buildings, shall be suitably protected against damage. Through walls and floors this shall involve an appropriate type of sleeve, through any form of metalwork or stiff plastic then a rubber grommet shall be used.

8.3.11 Data Patch Panels

8.3.11.1 The Contractor shall take cognisance of the ICT requirements and provide patch panels to meet the outlet requirements. 100% patch leads shall be provided with colours and lengths to be confirmed.

8.3.12 Data Outlets

8.3.12.1 The data and voice outlets will be RJ45, CAT6 augmented type with angled connector.

8.3.13 Public Address Systems

8.3.13.1 The Contractor shall provide a public address system to allow zoned emergency messaging throughout the hospitals, Lifts, Building links, tunnels, FM and Energy Centre together with external mustering areas, supplemented by local background music and zoned PA to allow entrances, receptions, atria, changing rooms and waiting areas to operate in line with the Clinical Requirements.

8.3.13.2 The emergency messaging shall be controlled from two locations and the system shall incorporate pre-recorded coded messages.

8.3.14 Staff Location System

8.3.14.1 Pagers to be integrated in the BMS and Telephone Systems to suit the Board Requirements.

8.3.15 Patients/Nurse Call Systems/Personal Attack Alarm

8.3.15.1 Nurse Call Systems

8.3.15.1.1 The Contractor shall provide a comprehensive Nurse Call System integrated within the BMS networking systems at all bed locations (and en-suites), Nurse Stations, Toilets and Showers, TV Rooms and all other areas frequented by patients. The system must be capable of emitting both audible and visual warnings for the following situations:

a) To summon a nurse (Patient to Nurse); and

b) To highlight a medical emergency (Nurse to Nurse).

8.3.15.1.2 The installation shall have the following functionality;

Ensure that both visual and audible warnings are sited in positions that enable the appropriate staff to respond to the exact location of the call both efficiently and effectively.

Ensure that the warnings, both visible and audible, should be specific to the type of emergency and must be consistent throughout all areas of The Works.

Provide systems that comply fully with the requirements of relevant S/HTMs and S/HBNs. In addition these systems shall enable on-screen alerts at locations to be agreed with the Board.

Ensure that the nurse call button / cord meet the need of the particular patient that may be required to use The Works. Patients may have cognitive problems or have difficulties with mobility.

8.3.15.1.3 A nurse call system is to be part of every bed head service. A patient hand unit with a call button is to link to an indicator panel at the Ward Nurses Station. The system is also to link to call buttons in other areas such as WC's, Bathrooms and Quiet rooms. The system shall include the following facilities:

a) Ensuite protection;

b) Over-door indicator lights;

c) Ability to link calls between adjacent wards; and

d) Cardiac arrest or 'crash' call alarms taken back to a 24 hour manned point to allow the 'crash' team to be paged

8.3.15.1.4 The Contractor shall provide a flexible system which annunciates within the nurse station with route indicators to the activated unit. Each bed system shall be transferable to adjacent and remote nurse stations via a hierarchical password control system to meet the Nursing requirements of the flexible ward configurations.

8.3.15.1.5 The system configuration shall be interlinked with the central PC based bed management system.

8.3.16 Clinical Equipment Alarms

8.3.16.1 Each clinical drug cupboard shall be alarmed as follows;

a) Light externally over door to room

b) Back to Nurses station

c) Back to local office to warn of unauthorised access.

8.3.16.2 The Contractor shall provide a system by which clinical Equipment alarms can be annunciated at a designated location during working hours but out of hours alarms can be directed to a designated member of staff, off-site. The Contractor shall determine all Equipment alarms of this nature.

8.3.17 Call Systems

8.3.17.1 The call systems or speech transfer systems shall be provided by the Contractor where normal speech is impaired by the use of glass security partitions or similar barriers. These shall generally be at public entrances and secure receptions these should contain staff control unit, speakers and microphones.

8.3.18 Induction Loops

8.3.18.1 The design of The Works shall include a comprehensive system of induction loops (fixed or portable) with suitably located dedicated sockets and signage such as to;

a) Reception areas;

b) Bedded bays;

c) Single Rooms;

d) Treatment Rooms;

e) Consulting Rooms;

f) Counselling Rooms; and

g) Interview Rooms.

8.3.18.2 Additionally, the design shall reflect these requirements in areas such as offices where staff may require this facility.

8.3.18.3 The Contractor shall provide induction loop or infrared systems in accordance with DDA requirements. The final provision and locations are to be agreed with the Board, dependent upon the final design solutions.

8.3.18.4 Portable hand held systems for use by visitors shall be made available at Reception. This shall ensure that the parts of The Works not provided with Induction Loops or infrared systems are made accessible to all users.

8.3.18.5 The “ear” symbol denoting the presence of an induction loop shall be prominently displayed. A sign shall explain clearly to people using hearing aids how they can benefit from the Induction Loop.

8.3.18.6 Alternative, proven systems that do not raise issues of patient confidentiality can be proposed by the Contractor to provide facilities wide coverage as appropriate.

8.3.18.7 The Induction Loop system shall be interlinked with the speech transfer system in order to provide a neat and unobtrusive configuration and an aesthetically discreet installation.

8.3.19 Television Installation

8.3.19.1 The contractor shall negotiate with a patient entertainment system supplier and provide the required backbone broadband cabling and wire ways and control room facilities for a leased patient entertainment system, to be installed at all bed heads in the Adult Hospital. Bed Head systems to provide:-

a) Television;

b) Radio;

c) Telephone; and

d) Game and internet services (optional at point of use)

Together with the associated infrastructure to allow these to be charged on a pre-payment basis.

8.3.19.2 Within areas were a conventional bedside screen is not suitable, the Contractor shall provide an alternative solution for location of the screen.

8.3.19.3 The Contractor shall provide a fully operational patient entertainment systems in the Children's Hospital to provide:-

a) Television;

b) Radio;

c) Interactive games;

d) Music;

e) Art; and

Protected Internet services.

8.3.19.4 In addition to facilities at each bed head, in the Children's Hospital, entertainment systems consisting of TV, DVD and games systems will be provided in the main waiting and play areas. These will require a central TV and radio reception and distribution system provided by the Contractor.

8.3.20 TV & Radio Facilities

8.3.20.1 The Contractor shall provide the infrastructure for reception and distribution of television and radio for use by patients, visitors and staff. This shall include external aerials / dishes, containment and cabling / distribution to enable radio (inc local hospital radio), and both digital satellite / terrestrial TV services to be distributed throughout The Works.

8.3.21 Lightning Protection & Earthing

8.3.21.1 The Contractor shall provide a lightning protection system for the protection of the structure, the contents and occupants. The lightning protection installation shall be in accordance with BSEN62305. The lightning protection system shall comprise of air termination network, down conductors, earth termination network, type 1 and type 2 surge arrestors and all required equi-potential bonds.

8.3.21.2 Surface fixed down conductors are not acceptable.

8.3.21.3 The Contractor shall provide a system of earthing comprising earth electrode systems, main and supplementary earth bars, main and supplementary equi-potential bonding, to ensure sufficient and fast operation of protective systems in the case of earth faults.

8.3.21.4 The earthing system shall comply with (S)HTM 06-01, BS7430, and BS7671 and with the Electricity at Work Regulations.

8.3.22 CCTV/Security Systems

8.3.22.1 General

8.3.22.1.1 The systems shall be closely integrated with the BMS to provide an integrated central monitoring and management facility. The Contractor shall provide security systems specifically designed to meet the requirements of each department / unit.

8.3.22.1.2 The systems shall present a secure and reassuring environment for staff, patients and visitors by providing appropriate security measures within the particular restraints imposed by clinical demand and personal freedom.

8.3.22.1.3 The design for all security systems shall be in line with the general principals of the approach recommended by Secured by Design refer also to section 7.

8.3.22.1.4 Local security systems alarm annunciation shall be provided within wards and at the central security facilities with remote monitoring and control off site at the Hillington Control Centre.

8.3.22.1.5 The main receptions shall also incorporate a CCTV monitor positions each with a flexible control facility to allow a combination of monitoring arrangements over two 20” Flat LCD screens.

8.3.23 Panic Alarm Systems

8.3.23.1 The Contractor shall provide panic alarm systems integrated within the BMS. Staff attack alarms will be provided by activation of a fixed discrete push button, hard wired to the underside of reception desks. All principal reception desks and staff bases will be provided with this facility.

8.3.23.2 Staff mobile panic alarms will be provided with link to receptions and security in the following areas:-

a) Accident & Emergency

b) Imaging (out of hours)

c) Pharmacy

d) Emergency Decontamination

e) Out of Hours Service Areas

8.3.23.3 All panic alarms fixed and mobile shall be monitored by the on site FM Control Centre and the remote Hillington Control Centre this shall provide a description of the alarm activation highlighting the precise location of staff members in distress.

8.3.24 Paging, Personal Attack Alarms

8.3.24.1 The Hospitals shall be installed with a radio-frequency network to facilitate the use of paging and personal attack alarms integrated within the BMS. This radio-frequency network shall include location beacons so that the exact location of pagers and attack alarm devices can be determined.

8.3.24.2 The radio-frequency network infrastructure shall be compatible with the Identicom personal security device, which is used widely across the NHS to provide lone-worker protection.

8.3.24.3 Panic buttons linked back to the FM Control Centre, and with a loud alarm at the scene, are to be installed at Reception desks and in Treatment Rooms

Decontamination room to be secured and fitted with Panic Alarm and two way intercom to adjacent area.

8.3.24.4 Treatment space in the Emergency Department to host CatA prisoners required (incl terrorist suspects transferred from 'G' Div HQ at Helen Street). This as well as decontamination room to have discrete entrance (double bank decontamination facility, have lobbies and two areas and may require armed escorts to be present. Provide lobby, seating, WC etc to support together with controlled ingress and egress and airlock type doors.

8.3.24.5 Police room in Emergency Department area to be fitted with panic alarm facilities.

8.3.24.6 The system shall be networked with the central management system and linked with other systems to allow:

The unlocking of doors along all escape routes to assist evacuation in an emergency.
Possible automatic locking of doors within an area if a panic button is pressed.
Activation of a security camera in a particular location when a door is opened to provide a picture of the person entering.

8.3.24.7 All A&E entrances shall have Video Access Control System for use at night time so that security staff can control entry from the desk positions in accordance with the Secured by Design recommendations.

8.3.24.8 General staff panic alarm system shall be integrated within the Wi-Fi network to allow staff to operate two stage affray facility within the hand held electronic PDA type equipment. This shall be configured to triangulate the location of staff members in distress and provide a department location.

8.3.25 Alarms & Intruder Detection System

8.3.25.1 The Contractor shall provide an IDS System within The Works to provide out of hours security cover. This shall be provided by PIR Detectors located within the corridors, rooms with ground floor windows, and rooms internally adjacent to any roof access points. In addition The Contractor shall ensure that restricted areas have door contacts available for monitoring unauthorised entry.

8.3.25.2 The following areas shall be fitted with local intruder alarm systems:

a) Pharmacies (to prevent the theft of controlled drugs)

b) X-ray department areas used for storing silver chemicals

c) Patient record offices

d) Stock rooms

e) Plant rooms

f) FM areas

g) All external doors

8.3.25.3 The intruder alarm systems shall link centrally back to the FM Control Centre.

8.3.25.4 The Contractor shall ensure that the proposed alarm systems for The Works include lifts, refrigeration equipment and all other critical equipment.

8.3.25.5 The Contractor shall ensure that the alarm systems can be securely monitored on Site and also remotely at the Hillington Control Room.

8.3.26 Security Access Control

8.3.26.1 The Contractor shall provide a comprehensive access control system to all external access doors and to internal doors requiring restricted access including access control doors to each ward and departments integrated within the BMS and plant area lighting controls to prevent unauthorised access. Control will be via a hierarchical proximity card system. Some departmental systems may only be activated outside normal working hours.

8.3.26.2 Ward access control doors shall also be fitted with CCTV camera and door access system. The CCTV camera shall be suitable for viewing of visitors in wheel chairs.

8.3.26.3 The Contractor shall provide the Entry requirements of SHPN57 e.g. Entrance to be controlled by use of entry-phone intercom system with CCTV linked to the reception/clerical office and communications base with access control provided across the full Critical Care Accommodation including changing room doors

8.3.26.4 Controlled access shall be provided by the Contractor to the Estates and FM vehicle hard standing and parking facilities for vehicles and pedestrians, traffic management lights and barriers shall be provided to control the yard and the associated slip road.

8.3.26.5 The Contractor shall ensure the system includes all necessary power supplies, card readers, actuators, egress buttons and emergency “break-glass” release units and fire alarm interfaces.

8.3.26.6 The system shall utilise the BMS LAN with separate field cabling and all necessary central controls / network cards provided suitable for future extension.

8.3.26.7 The system shall be interfaced with the robotics system to ensure that controlled access is provided while maintaining system integrity.

8.3.26.8 The system shall be interfaced with the theatre system to ensure that controlled access is provided while maintaining operational integrity.

8.3.26.9 The Contractor shall provide door entry video intercom systems to the designated main entrance doors and the delivery entrances with local control and facility to transfer to the main security room.

8.3.27 External CCTV

8.3.27.1 The Contractor shall provide a comprehensive colour CCTV system integrated within the BMS covering all external access points, car parking and external pedestrian/cycle circulation routes around the full Site including FM, service yards, car parks, walkways, boundary of/entrances to Site, boulevard, service tunnel etc, and the general road network.

8.3.27.2 The design shall also take cognisance of the Board's security requirements as detailed in the Boards operational requirements.

8.3.27.3 The Contractor shall ensure that the system comprises a multi-channel digital recorder with a recording frame per second for each camera which is in accordance with a detailed engineering specification to be agreed with Strathclyde Police.

8.3.27.4 The digital recorders shall also control playback of images onto a CCTV monitor.

8.3.27.5 The cameras shall be fully functional set up with stops to avoid over viewing adjacent properties, the RAID storage shall be 25 frames per second and all equipment shall be selected to provide good quality viewing and reproduction for use in prosecutions.

8.3.27.6 The external PA system shall be linked to cameras so operator can 'speak' to persons in external spaces in emergency or to reprimand/warn.

8.3.27.7 The system shall be fully integrated with the new Laboratories system and shall be configured to allow migration of the retained estate equipment without downtime.

8.3.28 Internal CCTV

8.3.28.1 The Contractor shall provide a comprehensive colour CCTV system integrated within the BMS covering all corridors, reception, lift lobbies and other areas where members of the public gather or areas where access is to be restricted i.e. wards.

8.3.28.2 CCTV cameras shall be installed at the main entrances, waiting and circulation areas of both hospitals where the security and safety of hospital staff and patients is a concern but where free access for the visiting public is allowed. The CCTV systems are also to cover:

a) All Exits and Entrances;

b) Ambulance Parking;

c) Vehicle Bays;

d) Fill points;

e) Cycle sheds;

f) All vehicle and cycle routes within the works;

g) All footpaths within the works;

h) Pharmacy Counters;

i) Ward Entrances;

j) Children's Play Areas;

k) Ambulance Entry Points;

l) A&E Departments;

m) Car Parks, Estates Yards, Public Spaces;

n) Generator Plant rooms;

o) Main Heating Plant rooms;

p) Corridors;

q) Receptions;

r) Lift lobbies; and

s) Other areas where members of the public gather or areas where access is to be restricted.

8.3.28.3 All CCTV cameras will be IP-based. They will be linked back to local hubs by fibre or Cat.6A cabling. Local data hubs will be connected back to a number of CCTV servers adjacent to electrical risers, which will in turn be linked to the main server room via a looped optical fibre network. CCTV servers will include input modules, processors and RAID storage. The system shall record at 25FPS per camera and provide 31 days storage. Each CCTV server will also be provided with an independent broadband connection to provide connectivity in the event of a network failure.

8.3.28.4 All cameras shall be linked back to the FM Control Centre and the off site facility at Hillington with local supplementary monitors in accordance with the Clinical Requirements.

8.3.28.5 The Police room in Emergency Department area to be fitted with CCTV monitors, to receive feeds from the Emergency Department cameras and any other surveillance as provided under the control of the main CCTV monitor position.

8.3.28.6 The CCTV system shall be linked to the intruder alarm and access control systems to provide specific viewing functions, such as presenting a picture on a monitor when an access card is presented to a reader, or when a movement detector activates.

8.3.29 Automatic Barriers

8.3.29.1 The Contractor shall provide all vehicle access barriers including associated power and control wiring. For Vehicle control at the A&E, FM to suit the developed traffic philosophy. Facilities shall be provided for audio visual links to the security desk to provide assistance. The Contractors shall also provide additional ducts and network cabling to strategic areas for future pay stations.

8.3.30 Uninterruptible Power Supplies (UPS)

8.3.30.1 The provision made for interruptible/ uninterruptible power supply (IPS/UPS) solutions to provide electrical safety in the patient environment shall be based on IEC 6034 for Electrical Installations in Medical Locations, (S)HTM-06-01 and the recommendations of Guidance Note 7 to BS7671 Wiring Regulations published by the Institution of Electrical Engineers.

8.3.30.2 UPS solutions shall also be provided by the Contractor to support Grade A standby lighting in Group 1 and Group 2 locations within areas of clinical risk 4 and 5.

8.3.30.3 The Contractor shall provide the UPS requirements of SHPN57 e.g. all patient supplies in Critical Care areas shall be UPS backed, dedicated plug arrangements shall be provided rather than colour coding to differentiate.

Lighting in Critical Care areas to be UPS backed, this element of the requirement may be provided from of series of resilient redundant "lighting off line" battery inverter units rather than from the main series of "on line" UPS sets.

8.3.30.4 UPS units shall be located to suit the load requirements and the Contractor shall allow for UPS resilience, redundancy, automatic by-pass and ensure that the equipment is provided with the appropriate environment to ensure full design life is achieved from all equipment and batteries.

8.3.30.5 Consideration shall be given to UPS island mode operation with measures taken to ensure that the output neutral is referenced to earth at all times e.g. bypass and isolation transformers permanently in circuit with local connection or reconstituting the UPS neutral –earth bond as required.

8.3.30.6 Batteries shall be minimum ten year design life type in accordance with British Standards, these shall be provided in cabinets and battery monitoring and battery isolation devices shall be linked to the central monitoring system.

8.3.30.7 Battery cabinets shall be located in separate plant rooms from all heat generating equipment with appropriate environmental conditions to provide a safe steady state environment for maximum battery life.

8.3.31 Generators

8.3.31.1 The site generation shall be sized to provide stand-by power for The Works and Laboratory with provision for integration of the retained estate.

8.3.31.2 The system shall comply with the distribution requirements of (S)HTM-06 as set out in the schematic drawing ref G1274/E(60)01 and the generators shall have sufficient capacity to pick up the load and meet the minimum frequency and stability requirements for the Emergency System after loss of mains power taking into consideration the site load including Medical equipment, UPS and HVAC variable speed drives.

8.3.31.3 Load management control shall be utilised to ensure that the lighting and small power are reinstated within 15 seconds of power failure. All other loads including Mechanical Services and Lift power shall be re-instated in a controlled manner within 25 seconds of power failure. The Contractor shall include for all load management software and hardware including automated motorised ACB's and MCCB's to ensure that the load management matches the generator status. The Control shall be run over twin redundant PLC's with automatic change over in the event of fault. All control circuits shall be constantly monitored for healthy operation and communication with faults indicted at the Plant rooms with remote indication via the BMS.

8.3.31.4 Active mimics shall be provided via touch screen PC's within each main switchroom to indicate the status of all main electrical plant and emergency systems.

8.3.31.5 All power for controls and monitoring equipment shall be provided from resilient supplies with UPS/ Battery backup, with back up to allow maintenance without system downtime.

8.3.31.6 A full load analysis shall be carried out to ensure that the appropriate generator sets are selected to meet the active power, reactive power and apparent power requirements and that change-overs are bump free with a maximum permissible voltage dip of 2% on load acceptance.

8.3.31.7 The alternators shall be selected to match the inrush current of the transformers which shall be brought on line (with lighting and small power loads connected) when one of the generators in each group is available on the bars. The remaining generators shall synchronise to the first unit in their group and signal to the load management controls when sufficient units are available to take the remaining loads.

8.3.31.8 Generators shall be rated as ISO8528 (2005) Continuous Operating Power COP.

8.3.31.9 Full load management shall be provided by the Contractor to allow isolated island running and parallel utility operation.

8.3.31.10 The engines shall comply with ISO 3046-1 and generators comply with ISO 8528.

8.3.31.11 To improve system resilience the generators shall be located in groups with Fire and Blast Separation.

8.3.31.12 Digital Automatic Voltage Regulations (AVR) shall be provided with optimized transient response to suit site load.

8.3.31.13 A stringent series of “Black Building Tests” shall be developed by the bidder to indicate cause and effect for all of the system fault scenarios, this shall be build up in iterations with simple single system faults escalating to major inter system failures in a matrix.

8.3.31.14 An override facility shall be provided via Castel interlocking to allow a controlled manual engine start up procedure to be available in the event of PLC failure.

8.3.31.15 Once the Matrix is agreed the tests shall be integrated in the overall commissioning strategy.

8.3.31.16 The fuel storage shall be integrated with the standby heating fuel system to provide a modular storage facility as described elsewhere.

8.3.31.17 Each generator shall be provided with a dedicated gravity feed day tank capable of tuning the set at maximum load for 10 hours.

8.3.31.18 A resilient dual piped, multiple pumped supply system shall be provided from the Modular Storage to deliver to the day tanks.

8.3.31.19 All engines should incorporate lean burn technology to minimize NOx, flues shall be run to the energy centre stack and discharged at high level.

8.3.32 Plant Rooms

8.3.32.1 The plant rooms shall be configured to ensure optimum environmental conditions to ensure efficient operation.

8.3.32.2 All walls, ceiling and floors within generator rooms, transformer rooms, MV and LV switchrooms shall be painted to minimize problems associated with dust.

8.3.32.3 All floors and roofs to be of water proof construction with all penetrations formed in bunded up-stands incorporated in the water proof design.

8.3.33 Theatre Panels

8.3.33.1 The Contractor shall provide proprietary theatre panels of touch screen design to meet the Clinical Requirements and provide a centralised control and monitoring position within the Theatre for all Electrical and Environment Systems including Mains power, Generator power, UPS power, fire alarms, temperature, humidity, theatre lights, room lights etc.

8.3.34 Lifts and Escalators

8.3.34.1 The Contractor shall provide bed passenger lifts (suitable for inclusion of at least one hospital bed (orthopaedic bed), goods lifts, service lifts, general passenger lifts, clean goods lifts, dirty goods lifts, FM robotics lifts, dumb waiters and evacuation lifts within the buildings in accordance with (S)HTM 2024 and EN 81. Evacuation lifts for emergency conditions will be considered within the fire strategy and shall be provided if required as part of that agreed strategy. All lifts provided for the movement of patients shall be supplied from the essential services supply in accordance with (S)HTM 2011.

8.3.34.2 The Contractor shall give consideration to the following in the provision of lifts:

a) The lifts shall be vandal / damage resistant but aesthetically pleasing and appropriately sized (lifts designated as passenger bed lifts shall be sized to accept as a minimum a bed and associated equipment);

b) Banks of lifts shall be appropriately controlled to maximize movement;

c) Collective controls of groups of lifts shall be used;

d) All floors including plant levels shall be served;

e) Control rooms shall be easily accessible and designed to minimise the need for artificial cooling;

f) All Lift power shall be via automatic changed over units with power fed from either side of the dual power distribution systems;

g) Emergency hands free telephones in lifts shall be accessible to the blind, partially sighted, deaf and wheelchair users. The Contactor shall link each lift car emergency phone directly to an individual emergency line at the Boards central communications centre, to facilitate emergency clinical support and communication, this shall be in addition to the lift remote fault reporting system provided by the lift suppler;

h) Remote lift operation monitoring shall be provided;

i) Lifts for people and goods shall be separated;

j) Dedicated lifts are required for theatres or swipe controlled staff access override;

k) Key operated Priority Control shall be provided for bed movement and a local controller shall be provided within the helicopter recovery area;

l) Manual Handling shall be reduced with the introduction of Automated transfer Systems which shall be integrated in the vertical transport solution. The Contractor shall clearly set out the number of lifts indicating if these are dedicated to Automated Transfer System or shared with the FM units;

m) All lift car levelling requirements shall be in accordance with the British Standards and also be in accordance with the Automated Transfer System step capabilities if this is less tolerant than the British Standard;

n) Lifts shall be conventional type rather than machine room less type to ensure operation of the Boards passenger evacuation procedures;

o) Escalators to be selected to meet the traffic flow in accordance with the Bidders scheme, units shall be designed and installed in accordance with BS5655;

p) The Bidders shall carry out vertical transport analysis for passenger, bed movement and FM movements and automated material transfer systems based on their proposed scheme and the clinical and operational requirements;

q) Lift and escalator ratings speeds shall be selected to ensure excellent service complete with inbuilt redundancy to allow for unit breakdown and planned maintenance;

8.3.35 Tagging

The Contractor shall provide a full asset tagging system in accordance with the NHS Scotland (HFS) National asset management requirements.

All installed Electrical, Mechanical, Public Health Medical Gases and Specialist systems components shall be asset tagged by the contractor, entered into the PPM system and linked to its full specification and maintenance schedule.

The tagging system shall be capable of simple extension to allow the Bar Coding of Hospital Equipment, and the bidders shall provide technology proposal for Board consideration.

The asset tagging system shall be interfaced with the PDA System to be utilised for Managing Building Handover and Snagging.

8.3.36 Service Tunnels

Full resilient building services shall be provided in the service tunnels including, ventilation, smoke control, heating, small power, lighting, emergency lighting, illuminated signage, fire alarms, leak detection, access control, public address/background music and CCTV etc. to allow the tunnels to continue to operate during sectional maintenance.

The tunnels shall be configured to meet the developed traffic flow requirements, with full consideration of the Automated Material Transfer System operation requirements including power, ventilation, unit recovery, weight, gradient and step limitations.

Special consideration shall be given the risk of single point of failure within the tunnel and the main services shall be separately routed with dedicated maintenance access provided to allow ongoing operation during maintenance.

8.3.37 Laboratory Services

All specialist services e.g. security, access control, CCTV, fire alarms BMS etc within the new hospitals shall be fully compatible with building the services to be provided in the Laboratory Building.

8.3.38 Future Proofing

The Contractor shall ensure that all systems are future proofed and shall provide a compliance matrix indicating measures taken in their supply chain to indicate the level of future proofing included in their bid.

SECTION 8.4 - DRAWINGS (these are located in Appendix M)

Schematics	Number G1274-
Main Power Schematic	E/(60)01
Power Distribution Schematic	E/(60)02
Fire Alarm Schematic	E/(67)01
CCTV/Staff attack & Intruder Schematic	E/(68)01
Nurse Call Schematic	E/(68)02
Data Schematic Diagram	E/(68)03
Typical CWS Distribution Layout	P/(53)01
Wet Riser Distribution Schematic	P/(67)02
Medical Gas Pipeline System Schematic	M/(54)01
Natural Gas Schematic	M/(54)02
Sprinkler Installation Schematic	P/(67)01
Chilled Water Distribution Schematic	M/(55)01
MTHW Distribution Schematic	M/(56)01
Typical LTHW Distribution Schematic within Building	M/(56)02
Isolation Suites, plant room adjacent Ventilation System	M/(57)01
Isolation Suite Vent System plant room above	M/(57)02
Typical Adult Ward Tower Ventilation Schematic	M/(57)03
Operating Theatre Ventilation Outline Plan and Schematic	M/(57)04
Site Layout Drg's	Number G1274-
Water, Gas and electric Site Incoming Services	U(96)01
Indicative MTHW heating distribution route	M/(56)03
Energy Centre	Number G1274-
Proposed Energy Centre Plant room layouts MTHW Solution	ME/(60)01
Indicative Primary Sub Station Layout	ME/(60)02
Detail Drawings	Number G1274-
Indicative layout of Main Services Tunnel	ME/(60)03
Board Drawing	
Existing External Services Site Plan	G1700X G(52)Combined-Site

Section 9.0 Civil & Structural Engineering Requirements

The Contractor shall in carrying out the Works comply with the following non-exhaustive list of civil & structural engineering requirements.

9.1 General Requirements

9.1.1 The Contractor shall ensure that the design and construction of the civil and structural engineering elements of the buildings and external works meets the following criteria:

a) Be designed observing due skill, care and attention to the requirements of the brief;

b) Be fully co-ordinated with the design of the building fabric, finishes, services, facades, internal walls, medical equipment and existing Site features, including buildings / structures;

c) Provide adequate space for the distribution of services, while maintaining the required finished floor levels and the floor to ceiling heights called for in the Room Data Sheets; and elsewhere in the Employers Requirements documents;

d) Maximise the clear zone above the ceilings for services to the degree consistent with overall economy for the Board;

e) Be economically adaptable to meet changing clinical needs; and

f) Require minimum maintenance and be designed to accommodate maintenance requirements for services, equipment and building fabric.

9.2 Minimum Design and Construction Standards

9.2.1 Unless otherwise agreed with the Board the Contractor shall ensure that all structural and civil engineering elements are designed in accordance with current revisions of the following standards and guidance documents:

a) BS6399 - Loading for buildings or Eurocode 1 (incl. Eurocode 0);

b) BS5950 – Structural use of steelwork in building or Eurocode 3;

c) BS8110 - Structural use of concrete or Eurocode 2;

d) BS5628 – Code of practice for the use of masonry or Eurocode 6;

e) BS5268 – Structural use of timber or Eurocode 5;

f) BS8002:1994 – Code of practice for earth retaining structures;

g) BS8004:1986 – Code of practice for foundations;

h) BS8102:1990 – Code of practice for protection of structures against water from the ground;

i) BS8007:1987 – Code of practice for design of concrete structures for retaining aqueous liquids;

j) BRE Special Digest 1:2005: Concrete in Aggressive Ground;

k) BS5606:1990 – Guide to accuracy in building;

l) BS8000 – Workmanship on building sites;

m) BS8500 – Guide to specifying concrete;

n) Glasgow City Council Roads Development Guide;

o) Design Manual for Roads and Bridges;

p) Specification of Highway Works, published by The Stationary Office as Volume 1 of the Manual of Contract Documents for Highway Works;

q) The Traffic Signs Regulations and General Directions 2002;

r) The Traffic Signs Manual;

s) Sewers for Scotland 2nd Edition;

t) BS EN 752:2008 – Drain and Sewer Systems outside buildings;

u) BS EN 12056 – Gravity drainage systems inside buildings;

v) BS EN 1825 – Grease Separators;

w) BS EN 1295 – Structural Design of Buried Pipelines Under Various Conditions of Loading;

x) CIRIA C624: Development and Flood Risk – Guidance for the Construction Industry;

y) CIRIA C635: Design for Exceedance in Urban Drainage – Good Practice: 2006;

z) CIRIA C697: The SUDS Manual: 2007;

aa) CIRIA R168: Culvert Design Guide;

bb) The Water Environment (Controlled Activities) (Scotland) Regulations 2005;

cc) SPP7 – Planning & Flooding;

dd) Glasgow City Council – ENV 3 – Flood Prevention and Land Drainage;

ee) ICE specification for piling and embedded retaining walls, 2nd Edition;

ff) CIRIA 66S: Assessing Risks posed by hazardous ground gases to buildings: 2008; and

gg) WRAS information and Guidance Note No. 9-04-03. The selection of Materials for Water Supply Pipes to be laid in Contaminated Land.

9.2.2 The Contractor shall deliver the Works set out in accordance with BS5606 – Guide to Accuracy in Building Critical dimensions and setting out points shall be clearly marked on drawings.

9.2.3 Construction tolerances, unless otherwise stated by the Board shall be no greater than those specified in Tables 1 and 2 of BS5606. Where the operational constraints of the building require special levels of construction accuracy then The Contractor shall be responsible for establishing and designing for these.

9.2.4 The performance of components shall be in accordance with the appropriate British Standards.

9.2.5 The Contractor shall ensure that building structures are designed to resist imposed, roof and wind loads not less than those required by current revisions of BS6399, Loading for Buildings.

9.2.6 The Contractor shall ensure that building structures are designed to carry the loads of heavy plant or medical equipment (including ceiling mounted tacking hoist systems) in their permanent positions and any loads that will be imposed upon the structures during the installation, removal or replacement of such heavy items. This requirement may involve the design of 'strong routes' through the buildings and/or specially strengthened areas of the roof onto which heavy items can be lifted.

9.2.7 The Contractor shall ensure that any measures considered necessary shall be taken to protect the building from ingress of naturally occurring ground gases e.g. carbon dioxide, carbon monoxide, methane and hydrogen sulphide.

9.2.8 In addition to reference to the above Performance Standards the Contractor shall take cognisance of the comprehensive list of relevant compliance documents as detailed in Section 5.1 of Employers Requirements: Minimum Design & Construction Standards.

9.3 Loadings & Structural Flexibility

9.3.1 The Works shall be designed to cater for the dead loadings associated with the chosen materials for the structure, finishes, partitions and cladding to the buildings. As a minimum, it shall also be designed for the imposed loads as specified in current British Standards. The design shall also take into account the need for specialist measures to allow for the installation, replacement and removal of Special Equipment and associated services. Structural deflections shall be limited as necessary for the proper installation and functioning of specified equipment.

9.3.2 The Contractor shall account for (but not be limited to) the following loading schedule

a) General floor loadings – Dead and Live loads;

b) Point loads for Clinical equipment and Services;

c) Impact loads;

d) Vibration loads;

e) Special plant foundation loads; and

f) Service loads

9.3.3 The Contractor shall take account of concentrated point loads from both mobile and stationary plant and Equipment. The structure should incorporate reasonable measures to accommodate updated versions of such machinery without major disruption. In addition, the Contractor shall ensure that floors and supporting structures have the capacity for retro-fitting lifting devices for all fixed items of plant and Equipment weighing 35kg or more.

9.3.4 The Contractor shall take cognisance of the requirements in designated patient areas for ceiling mounted tracking hoists etc and such measures to allow for the installation of Special Equipment and associated services.

9.3.5 The Contractor shall ensure that specific areas of the Works satisfy particular requirements of the Board's operations or Equipment in those areas. Relevant constraints may include but are not limited to maximum allowable (structural deflections) differential settlement, (vibration) and the meeting of any constraints.

9.3.6 The Contractor shall take account of dynamic loads from general movement of people through to activities such as aerobics, dance or other rhythmic activities that can give rise to harmonic effects in poor design.

9.3.7 Lateral stability bracing systems shall not obstruct or hinder Clinical or Non-Clinical operations and shall not obscure the windows or doors.

9.3.8 The vibration response of the buildings shall comply with the requirements of SHTM 2045 and be compatible with the requirements of the Equipment to be installed.

9.3.9 With respect to the Works, the Contractor shall:

a) Take due account of future flexibility of the Works (in terms of future change of use and/or relocation of equipment);

b) Specifically make allowance for future flexibility of ceiling mounted lifting equipment in designated patient areas, including the requirement for re-configuration, extension and/or retro-fitting of lifting equipment i.e. the whole of the designated area shall be capable of accommodating re-configuration or retro-fitting;

c) Make specific allowance for items of particularly heavy equipment and/or other onerous loading conditions; and

d) Make specific allowance for installation, transfer and/or removal routes for heavy equipment throughout the Facilities.

9.3.10 Parts of the structure potentially subject to damage from trolleys or vehicles shall be designed with adequate protection to prevent such damage from occurring.

9.3.11 Structural deflections shall be limited as necessary for the proper installation and functioning of special mobile, rail mounted, or fixed Equipment.

9.3.12 The Contractor shall include, within their design, provision for removal, replacement and upgrading of installed plant and Equipment. As part of this element of design, a comprehensive replacement strategy shall be prepared for implementation. This strategy shall, wherever possible, consider how these activities can be undertaken whilst minimising disruption to the function of the completed Works.

9.4 Foundations & Sub-Structure

9.4.1 The foundations shall be designed and constructed in accordance with the relevant Codes of Practice, recognising the prevailing ground conditions at the site as identified in the Ground Investigation Report (contained in Appendix N) and historical ground investigation information issued with the tender. Where the Contractor considers there is insufficient ground investigation information within the information issued for tender purposes, he shall identify this and allow for carrying out further investigation as he considers is required.

9.4.2 The Contractor shall take due cognisance of:

a) Recognition of applied loading;

b) Settlement and its effect on new buildings, links to adjacent buildings, existing adjacent foundations and existing services;

c) Dewatering and its effect on new buildings, links to adjacent buildings, existing adjacent foundations and existing services;

d) Earthworks;

e) Basement construction and waterproofing category;

f) Possibility of uncharted services and existing buried structures; and

g) Utilities Diversions.

9.5 Basements & Tunnels

9.5.1 The Contractor shall refer to the Masterplan, Acute Adult and Children's Hospital, Laboratory and Energy Building drawings contained in appendices for proposed locations of basements and tunnels. Basements structures in the main hospitals will generally be provided for FM/distribution and plantroom/service areas. Basements areas in the laboratory building are generally for access to the labs and mortuary as well as services distributions. It is intended that significant size tunnels will be provided between and connecting basement areas. The tunnels will provide routes for distribution of services and movement of staff.

9.5.2 Basement and Tunnel structures should be designed in accordance with the recommendations of BS 8102. The Contractor should provide designs appropriate to use of these elements i.e. he is to confirm categories of design A, B or C and identify where each is employed

a) Category A – Technical Protection;

b) Category B – Structural Integral Protection; and

c) Category C – Drained Protection.

9.6 Movement Joints

9.6.1 Structural/movement joints shall not be located through:

a) Kitchen and food preparation areas;

b) Treatment and surgery rooms;

c) Any room that HAI~Scribe prevents a floor joint from being provided in (including Theatres for example);

d) Rooms requiring a sterile environment; and

e) Any room with (now or in the future) tracking hoists or other similar lifting equipment

9.7 Superstructure

9.7.1 The Works primarily comprise the following elements:

a) Acute Adults and Children's Hospital;

b) New Laboratories Building;

c) New Energy Centre; and

d) External works and roadways/infrastructure, including utilities.
(Multi-storey car parks by others).

General

9.7.2 The Contractor shall provide designs appropriate to the type of buildings and in appliance with all SHBN's, SHTN's HBN's and Codes of Practice. The design of each building should demonstrate.

a) Ability to withstand loads and load combinations imposed on the building, vertical, horizontal, dynamic, temporary etc;

b) Compliance with robustness (tieing) requirements of current Codes of Practice and Technical Standards (Scotland) i.e. progressive collapse requirements;

c) Provision of movement must be included in designs, horizontal, vertical, shrinkage, temperature effects etc;

d) Vibration sensitive equipment will be in use throughout the new faculties. Designs should take cognisance of vibration categories;

e) Integration of building services with structure will be a highly important part of the design process. The Contractor shall demonstrate how design coordination will be achieved;

f) All material used in the design of structures shall be compatible with each other and such things as finishes (e.g. Painted); and

g) The Contractor shall prepare and supply an overall Design Philosophy Statement which should include as a minimum, General Project information, The Site, Design Team Parties, Construction Programme, The Structural Scheme, Design Standard and Sources of Reference, Modelling and Analysis and Calculations and Checking.

Acute Adults & Children's Hospital

9.7.3 The building will comprise basements, large area footprint storied structure (podium decks) and ward block multi-storey towers in 4 wings with associated cores. The Contractor shall demonstrate load paths through the building, identifying such things as transfer structures, stability cores, basements, retaining walls and foundations.

9.7.4 It is anticipated that a Helipad will be provided at roof level. The Contractor shall demonstrate a design in compliance with HBN 15-03 Hospital Helipads and identify in particular,

a) Size of helipad;

b) Size of helicopter designed for a loading applied to roof structure;

c) Load transfer of helipad structure to hospital roof structure;

d) Ramp access from/ to pad/ roof; and

e) Integration with emergency services requirements, such as fire fighting systems.

New Energy Centre

9.7.5 The Contractor is required to provide a building structure housing the new equipment that will service the overall hospital development. It is anticipated that large heavy equipment, boilers, generators, CHP plant etc. will be integrated into the design. Large spaced, double storey heights etc. will be required.

New Multi-storey Car Parks (by others)

9.7.6 The Contractor is required to provide a road and drainage and external works design that reflects and takes cognisance of the overall site, including the provision of new multi-storey car parking. Refer to Masterplan Layout for locations and sizes/ capacity of new car parking requirements.

9.8 Fire & Corrosion Protection

9.8.1 The Contractor shall provide fire protection to all elements of structure and ensure fire ratings are in compliance with space used and the more onerous of Building Regulations/the Board's requirements.

9.8.2 The Contractor shall provide a corrosion protection system appropriate to the various structural elements and their location of the buildings.

9.8.3 The corrosion protection system used shall be relevant to type of structure and its structural function and its material and location within the overall building frame. All materials used shall be compatible with each other and with surface finish materials. Reference should be made to the design life of the building structures and finishes, refer Section 5.0.

9.9 Durability & Maintainability

9.9.1 All elements of the structure shall be capable of withstanding potential deterioration due to weather, ground conditions, wear and tear, and accidental damage relevant to their location and environment.

9.9.2 Where the requirement for maintenance is less than the required life expectancy of the element(s) practical and realistic arrangements shall be designed into the construction of the Works to allow for any necessary repairs, replacements and painting etc. to be carried out safely without compromising the operational activities within and around the Works.

9.9.3 Contractor to provide a strategy statement on maintenance and replacement.

9.10 Other Performance Requirements

9.10.1 The Contractor shall ensure that all building elements and retaining structures shall incorporate appropriate means to resist the passage of dampness, both into the building structure and fabric, and into the accommodation, including the resistance to any hydrostatic pressure. The Contractor shall ensure that all such construction shall be in accordance with the requirements of the Building (Scotland) Regulations 2004, BS8102 and Code of Practice CP 102 for Protection of Structures against Water from the Ground.

9.11 Underground Drainage

9.11.1 A 'Drainage Impact Assessment and Strategy Report' has been prepared (see Appendix L) and is prescriptive in outlining the requirements which are to be assessed and met in respect of the foul and surface water drainage from the development. The report covers, *inter alia*:-

a) The proposed surface water drainage strategy and the resulting surface water drainage network design considerations and projected amendments to existing culverted watercourses;

b) The proposed foul water drainage strategy, projected foul flows and the drainage network anticipated. The Contractor is required to confirm by calculation their own assessment of flows for the development;

c) Sustainable Urban Drainage criteria which require to be met for each element of the development. Again, the Contractor is required to review the requirements and develop appropriate methods for implementation of the treatment required;

d) The management and maintenance of the designed drainage systems shall be accompanied by a summary which details the residual requirements for maintenance of each element of the drainage system, including parts of the network prospectively vestable in Scottish Water; and

e) The criteria for assessment of Flood Risk for the designed drainage networks and the development as a whole. The requirements for mitigation of the assessed flood risk and the appropriate finished floor levels for access, egress and buildings are also outlined for the Contractors to address.

9.11.2 In the development of the guidance within the 'Drainage Impact Assessment and Strategy Report', the Contractor shall be responsible for liaison with the relevant stakeholders in agreeing connection requirements to the surrounding public sewers, watercourses and drainage networks. The Contractor is responsible for the design and construction of a drainage solution that meets all the requirements of and satisfies the relevant regulatory authorities including, but not limited to, GCC, SEPA and Scottish Water.

9.11.3 All phases of the development shall treat the disposal of surface water in accordance with the principles of 'The SUDS Manual' Report no C697 published by CIRIA (March 2007)

9.11.4 The Contractor shall provide, where necessary within the on-site drainage network any isolators, retention traps, interceptor tanks and other such devices necessary to prevent the discharge of any potentially dangerous or otherwise contaminative materials to the public sewers.

9.11.5 The Contractor shall design and provide separate foul and surface water drainage systems in accordance with the requirements of the Building (Scotland) Regulations 2004.

9.11.6 All drainage shall be designed to avoid the risk of local flooding and flooding of the system into which they discharge. Flooding of electrical equipment areas and areas where stray current leakage may occur in the presence of water shall be prevented.

9.11.7 Drainage shall be sufficient to ensure that no areas of standing water occur outwith extreme storm events. The drainage systems shall be capable of coping with, as a minimum, the foul loading and the storm event specified by the relevant authority and shall be considered an integral part of

the public sewerage system. This shall include any storage required on the public network to offset the assessed impact of the development.

9.11.8 The drainage system shall be capable of taking such detritus as may normally arise during the operation of the system and during normal and winter maintenance conditions and those within the design criteria of the relevant authority.

9.11.9 The Contractor shall design the drainage system in such a way as to minimise the requirement for internal manholes.

9.12 Roads, Footpaths, Cycle paths and Car Parking

9.12.1 The extent of adoptable and non-adoptable roads is shown on the Exemplar layout drawings.

9.12.2 The Contractor shall provide a network of internal roadways providing;

a) a spine road network through the site between Govan Road and Hardgate Road to facilitate the increased levels of Hospital traffic;

b) a road network through the site between Govan Road and Hardgate Road with designated provision for blue light ambulances, related and relevant to the position of A&E services at all phases of the development;

c) a public transport hub served independently served from (a) or (b) above and in keeping with the requirements of the 'Clyde Fastlink' proposals being promoted by Glasgow City Council;

d) service access to the relevant areas as indicated on the Masterplan, which will be independent of any of the networks in (a) – (c) above;

e) sufficient Ambulance provision at A&E as outlined elsewhere in these requirements, and separate provision for temporary private vehicle layover in the same environs; and

f) a taxi / car drop-off and layover bay at an appropriate location and geometry to effect the efficient and safe pick-up and dropping off of visitors and other users of the hospital facilities.

A maximum of 3,500 car parking spaces, comprising 2400 staff and 1100 visitor / patient spaces are being created on site by others. The Contractor shall require to liaise with the Board and the consultant teams and contractor(s) carrying out this work in order to establish common routes, levels and other relevant co-ordination requirements.

9.12.3 The layout and geometry of the network of internal roads shall be generally in accordance with the Masterplan and exemplar layout provided to the Contractor.

9.12.4 The Contractor will provide details of junction upgrades including priority control measures for blue light ambulances and provision for 'Clyde Fastlink' shall be developed by the Contractor in consultation with Glasgow City Council.

9.12.5 The Contractor shall design the construction of new roads in accordance with the Glasgow City Council 'Roads Development Guide' for a Traffic Distributor Road. Pavements shall provide a residual design life at the year of completion of the works of no less than 40 years.

9.12.6 The Contractor is responsible for all approvals and consents in relation to all on-site and any off-site road, footpath, cycleway or other transport requirement.

9.12.7 The Contractor shall ensure that all roads, delivery and refuse collection areas have sufficient headroom above them to allow for the passage of appropriate emergency, servicing, delivery or refuse collection vehicles and are designed to provide sufficient space to allow efficient manoeuvring of such vehicles without undue difficulty, risk of impact or adverse effect of exhaust fumes on occupants of the buildings.

9.12.8 All structures which support roads / footpaths / cycleway shall be designed in accordance with the relevant provisions of the Design Manual for Roads and Bridges, and assume design loadings equivalent to the maximum permitted vehicle on the public highway.

9.12.9 The Contractor shall ensure that all roads, car parks and other areas that may be used by fire appliances shall have sufficient headroom for such vehicles and are designed to allow their efficient manoeuvring. The Contractor shall agree with the Board the types of delivery vehicles, which require to be considered in the design. Refer to briefing paper, facilities service yard/compound in Appendix L.

9.12.10 New car parks within the Site shall be designed by The Contractor to comply with applicable SHTM, HTM, HBN 45, HFN 20, HFN 21 and the requirements of Glasgow City Council Roads Development Guide.

9.12.11 Details showing the phased construction of all temporary and new car parking facilities constant with the masterplan shall be provided by the Contractor.

9.12.12 Where areas of surface car parks are required to be traversed by vehicles heavier than 2500kg for maintenance or access purposes, the sub-base and surfacing of these areas shall be specifically designed by The Contractor for these heavier loads.

9.12.13 Roads, delivery and refuse collection areas, and car parks, together with their supporting groundworks and structures, shall be designed by The Contractor to provide full and sufficient access for inspection, maintenance and repair of roads, car parks, delivery and refuse collection areas, structures, underground and underground drainage, including existing drainage items such as manhole covers and drains. Where access for maintenance, repair or replacement of underground services is required under the terms of an easement, the design of all elements affecting the exercise of such an easement shall also be in accordance with the requirements of the company that has the right to exercise the easement.

9.12.14 The Contractor shall also comply with the following criteria:

a) To roads, footways, footpaths and cycleways, construction is to be bituminous and in accordance with Glasgow City Council's Roads Development Guide appropriate for a Traffic Distributor Road;

b) Proposals for differential surfacing to pedestrian crossing areas are sought and shall be submitted by the Contractor for approval. Surfaces shall provide 20 years life before replacement form the date of completion of the works;

c) Cycleways shall include green surface finish utilising a recognised surfacing material which will provide 20 years life before replacement form the date of completion of the works;

d) Pedestrian crossings: types, locations, lighting and controls shall be agreed with the Board (controlled crossings to be included, exact locations to be agreed at design development stage);

e) Kerbs: to comply as a minimum standard with BS7263, Part 1: Pre-cast Concrete channels and edgings;

f) Traffic Signs and Markings to be designed to The Traffic Signs Regulations & General Directions 2002 and The Traffic Signs Manual (part of the Design Manual for Roads &

Bridges), and for the Board's approval. Markings and signage shall dimensioned apposite to a road with a design speed equivalent to 30mph;

g) Supplementary signage to support the management of traffic to preserve the provisions in (a) to (g) above shall be submitted for the Boards approval. Furthermore, the Contractor shall design and provide appropriate signage external to the car parking and other facilities to ensure ease of navigation around the Site for intermittent or infrequent users;

h) Gradients outwith carriageways shall comply with the provisions of HBN 45 and the Building (Scotland) Regulations 2004 as applicable. No gradient in excess of 1:20 shall be allowed in parking areas (other than access roadways), and 1:15 on pedestrian staff, patient and visitor access paths from parking areas to the building entrances;

i) Parking bays: comply with the reference documents, HBN 45, HBN 20, HFN 21 and the item on gradients above. The minimum parking standard parking bay shall be 2.5 x 4.8 m. Variation from the standard (to make optimum use of the space for example) may be desirable and allowed subject to agreement with the Board; and

j) Traffic parking restrictions and parking management: to be agreed with the Board.

9.12.15 Designs shall cater for the access and parking needs of pedestrians and the physically disadvantaged. This shall involve catering for visitors and staff using different modes of transport in adapted vehicles and with multiple aids / equipment.

9.12.16 This is to allow tailgate access by disabled people without the need to set ramps or lifts down within the main circulation routes of car parks. The first and last accessible parking bays in a row of 'in line' spaces shall be provided with a minimum clear area of 1.2m to both sides.

9.12.17 Parking for the transport requirements of deliveries and waste disposal, ambulances, fire appliances and other specialist and emergency vehicles shall be segregated from public and staff parking.

9.12.18 Car parking provision shall take into account the following requirements:

a) Dedicated parking for those with disabilities, the elderly and those with small children located close to the clinical areas, especially for those with limited mobility and eyesight;

b) Space for larger vehicles, which may be fitted with wheelchair ramp or carrying specialist mobile equipment from / to the Works (such spaces will be larger than the normal car parking space);

c) Appropriate zoned parking for night staff as near as practical to the controlled night entrance for staff; and

d) Electric car charging facilities in a minimum of 20nr bays.

9.13 Other External Works

9.13.1 The Contractor shall design the external works for ease of navigation and progression around the site by staff, patients and visitors.

9.13.2 The Contractor shall seek advice from the Board to seek to minimise the risk of crime and vandalism on the Works. This advice shall be pro-actively sought by the Contractor as part of the design process.

9.13.3 The Contractor shall seek advice from Strathclyde Police's crime prevention representative on the proposals for external works to minimise the risk of crime and vandalism on the Site and the Works, including compliance with Secure by Design.

9.13.4 The Masterplan and accompanying landscape drawings demonstrate the general arrangements of the external works.

9.14 Hard Landscaping Requirements

9.14.1 The Contractor shall incorporate into the Works all associated hard landscaping for the Site, including but not limited to, the following:

a) Access and hardstanding for emergency and delivery vehicles;

b) Access for building maintenance and window cleaning;

c) Access and circulation for, visitors and patients on foot, bicycles, in cars or on public transport;

d) Parking for vehicles and bicycles including disabled facilities;

e) Drop-off facilities including lay-bys and bus/transport stops;

f) Service areas, as appropriate;

g) Accommodation for building services plant, waste and materials management, as appropriate;

h) Amenity areas for staff, patients and visitors;

i) Suitable pathways and paving;

j) Protection against noise and environmental pollution;

k) Security provisions, as appropriate;

l) Appropriate Site boundary treatment;

m) Walls, fencing, gates / barriers and hedgerows as appropriate along the Site Boundary and at particular locations inside the Site;

n) CCTV surveillance to all car parks, pedestrian routes, cycle paths, therapy gardens and other specified external areas;

o) External lighting;

p) Suitable means of shelter against adverse weather conditions at entrances, bus/transport waiting, and drop-off locations and covered links provided, as appropriate;

q) Automatic vehicle access barriers; and

r) Fire hydrants.

Section 10.0 Sustainability

10.1 Sustainability

10.1.1 The consideration and implementation of sustainable facilities is a key concern and requirement of the Board in all its functions and activities.

10.1.2 The particular low carbon and sustainability considerations and requirements of the Board are provided in Section 8.0 and Appendix M.

10.1.3 The carbon management plan of the Board is contained for reference in Appendix P.

10.1.4 Guidance with regard to the consideration and assessment of BREEAM points are contained in Appendix U for reference.

Section 11.0 Community Engagement

11.1 Community Engagement

11.1.1 The consideration and implementation of Community Engagement (CE) initiatives is of great importance to the Board. The requirements of the Contractor with regard to CE in relation to the Works are contained in Appendix V.

Section 12.0 Bid Return Requirements

12.0 Bid Return Requirements

12.1 The particular bid return requirements of the Board are identified and listed, along with the evaluation process, in Volume 3 of this ITPD.

12.2 It is anticipated that the bid return information will allow the Board to assess the bids and select a private sector partner to contract with.

12.3 The Contractor will then work with the Board through the Stage 3 Design Development period to produce the FBC design requirements as identified in Appendix K.

NHS Greater Glasgow and Clyde

New South Glasgow Hospitals (NSGH) Project

INVITATION TO PARTICIPATE IN COMPETITIVE DIALOGUE

VOLUME 2/1

APPENDIX M&E.3
PLANT STRATEGY & DESIGN CRITERIA

CONTENTS

The following fully operational sections are to be incorporated into all air handling units:

- Motorised damper
- Fog/frost coils
- Pre filter
- Energy recovery device with automatic control and bypass
- Fan
- Blast plate
- Cooling coils
- Eliminator
- High efficiency motors,
- Fans in air stream for efficiency
- Fan selection and control to develop full flow and pressure at highest efficiency
- Heater – battery *
- Steam injection humidifiers (where required) **
- Final filter
- Activated carbon filters for odour removal
- Manual isolation / volume control damper
- Active Chilled Beams

* Operating theatres main heater batteries shall be capable of heating the total air volume from minus 6°C to plus 35°C, this is to provide resilience, should the fog/frost coil fail or abnormal external conditions prevail.

** Humidifier sections to be provided on all Operating Theatre air handling units and other areas required for clinical operation in accordance with the SHTM's, SHBN's and RDS's.

2.4.3 Chilled Beams

The use of active chilled beams should be considered within all ward areas.

Active chilled beams will provide tempered, filtered air together with heating and comfort cooling of the space; thus providing effective local control of the environmental conditions.

Care must be taken in positioning of the chilled beams to ensure that cold draughts are avoided when they are in a cooling mode.

The control settings must ensure that the external elements of the beam are always above dew-point.

Beams must be easily accessible for cleaning and maintenance.

Fan coils shall not be acceptable for use in clinical areas

NEW SOUTH GLASGOW HOSPITAL

Clinical Output Specification

AREA	HAEMATO-ONCOLOGY

1. INTRODUCTION

The Haemato-Oncology ward deals with patients with a range of malignant and non-malignant haematology conditions. A high proportion of the patients receive chemotherapy and are immunocompromised, making them vulnerable to infection. Advice was requested from Dr John Hood, consultant microbiologist, regarding suitable ventilation to provide a protected environment for this patient group (please see below under 'ventilation').

The Services provided include:

Inpatient services
Day case services

The specialty has 14 inpatient beds and 4 day case beds. The day case beds are located within the ward area.

The Services provided exclude:

Children's services
Outpatient services

Special Room Requirements

- Intrathecal room
- Negatively pressured, ventilated pentamidine room.
- Rooms suitable for isolation of immunocompromised patients.
- For drug preparation, a large clean utility room is required.
- Adequate storage as we have a large amount of disposables.
- Gowning lobbies are not required.
- Access to filtered water for immunocompromised patients may be a requirement
- Day case patients will attend a small ward based day area. The day area should be capable of accommodating a trolley and 3 reclining chairs.

Ventilation

Please note the haemato-oncology ward area has a very specific function and a considerably higher than average requirement for additional engineering support/infrastructure. There should be no opening windows, no chilled beams. Space sealed and ventilated. Positive pressure to rest of the hospital and all highly filtered air >90%, probably best HEPA with adequate number of positive pressure sealed HEPA filtered side rooms for neutropaenic patients as in the Beatson West of Scotland Cancer Centre.

2. LOCATION AND LINKS

External Department Links

Close to	Reason	*Category
Pharmacy aseptic suite	Delivery of cytotoxic drugs	3
Critical care	Easy access	3

*1= Essential adjacent
*2 = Important 2 minutes walking
*3 = Desirable 5 minutes walking

3. ACTIVITY

The bed requirement for the specialty is derived from the Pan Glasgow Bed Modelling Exercise.

4. TRENDS

Nil known.

5. HOURS OF SERVICE

Current Hours of Service:

Wards operational 24hours / 365 days year

Proposed Hours of Service (if different):

None

6. WORKLOAD INDICATION (weekly)

Not applicable.

7. KEY OPERATIONAL PROCESSES / ISSUES

Heavy users of Haematology, blood transfusion and biochemistry laboratories.
Imaging CT, MRI and routine CXR.

Ward clerk would greet and admit patients at front of ward.

- Day area should be at the front of the ward to stop unnecessary traffic through ward area.

- All areas should be designed with infection control a key focus, eg use of scrub sinks, elbow taps etc to allow for good hand hygiene

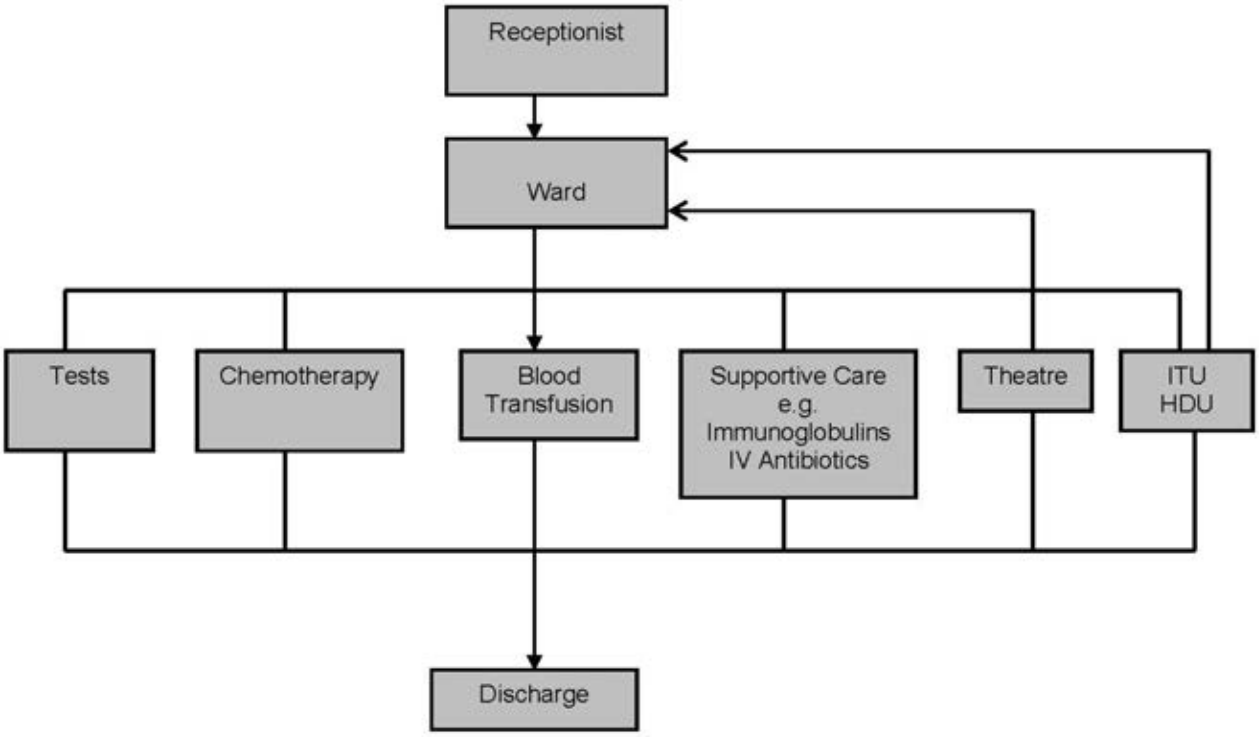
Ventilation requirements as detailed in introduction.

Ventilation

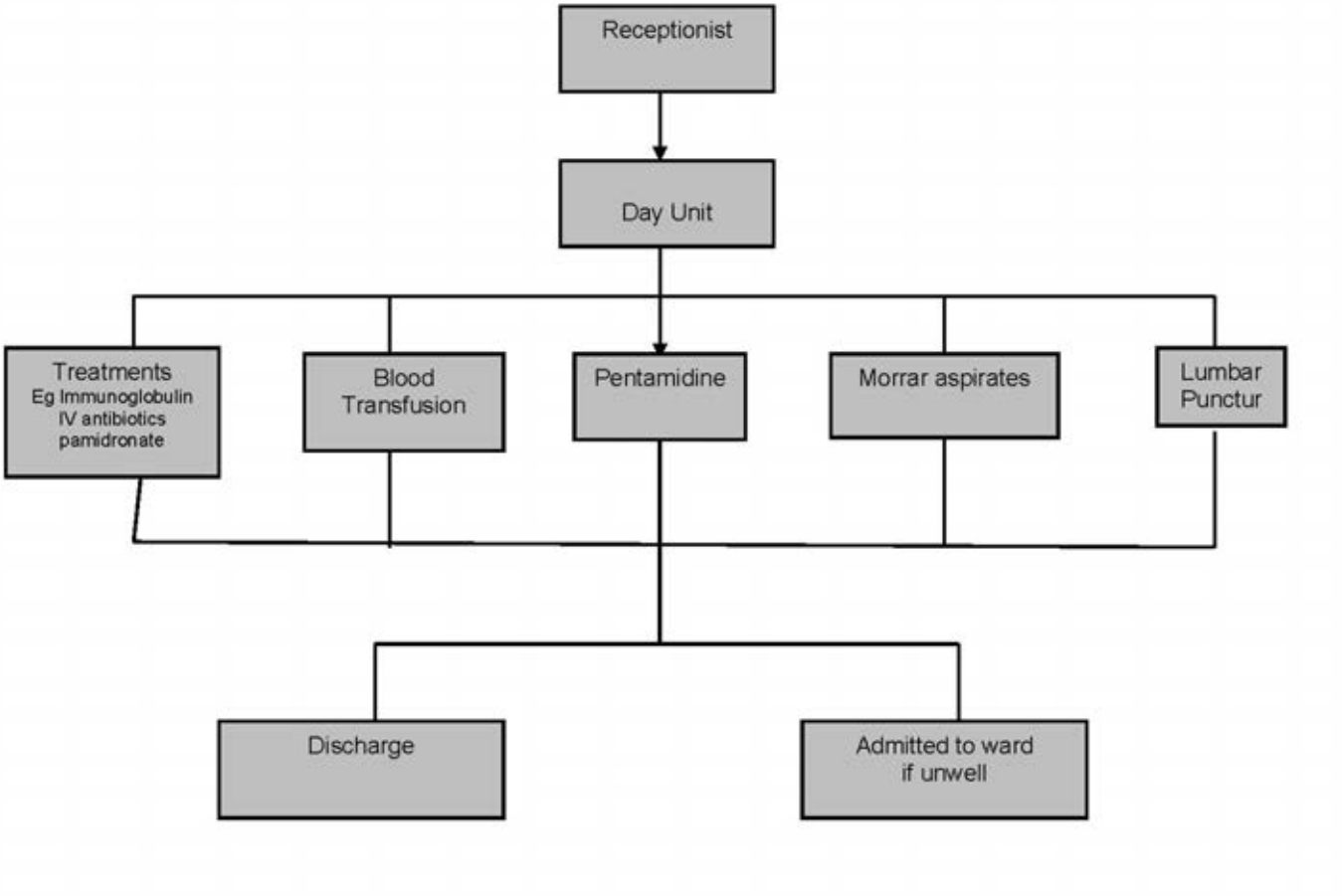
As described, for the haemato-oncology ward there should be no opening windows, no chilled beams. Space sealed and ventilated. Positive pressure to rest of the hospital and all highly filtered air >90%, probably best HEPA with adequate number of positive pressure sealed HEPA filtered side rooms for neutropaenic patients as in the Beatson West of Scotland Cancer Centre.

Require a negatively pressured, ventilated Pentamidine room. Patients will receive inhalations in this room and there must be frequent air changes to remove the contaminated exhaled air.

Inpatient Flow Chart



Day Case Flow Chart



8. EQUIPMENT

Heavy/bulky - Nil

New - Nil

Specific requirements - Nil

NEW CHILDREN'S HOSPITAL

Clinical Output Specification

AREA	HAEMATOLOGY& ONCOLOGY

1. INTRODUCTION

The department of haematology and oncology provides a tertiary service to the West of Scotland, and for some disorders / procedures a national service, for children with haematological malignancy, non-haematological malignancy and benign haematology.

The department is currently known as the Schiehallion Unit.

This report covers the following areas:

1) General In-patient Ward (high dependency)
2) National Bone Marrow Transplant Unit
3) Teenage Cancer Trust Ward and Day-Care facilities
4) Short-Stay / Day-Care Unit (incorporating the Regional Haemophilia Unit)
5) Clinical Administration Facilities
6) Outpatient Facilities

The National Bone Marrow Transplant Unit (BMT Unit), utilises special facilities incorporated into both the General In-patient Ward and the Day-Care Unit. Where applicable the requirements of the BMT Unit are noted within these sections.

The existing facilities accept new cases up to the patients' 16th birthday but a significant number of children continue treatment to the age of 18 years and over or until education is completed.

a) <u>The Services Provided Include:</u>

- Inpatient, Outpatient and Day Care tertiary services for children with leukaemia, solid tumours and benign haematology
- National Allogeneic Stem Cell Programme
- Regional Haemophilia Centre

b) <u>The Services provided exclude:</u>

The Beatson Oncology Unit at Gartnavel Hospital (NHSGG&C) provides a second 6 bed adolescent unit for patients aged 15 and over (sponsored by the Teenage Cancer Trust). Close working links between the Unit at RHSC and Gartnavel exist, and will be developed with the in-coming appointment of a dedicated Consultant.

2. LOCATION AND LINKS

As mentioned in the introduction, with the exception of Outpatient facilities, co-location of all other Haematology and Oncology is essential in order to maximise our existing resources, without having to rely upon any additional staffing.

<u>External Department Links</u>

Close to	Reason	*Category
Haematology Laboratory	The majority of patients attending Day Care / OPD will require 'bleeding' prior to their attendance. Results are required very quickly	1 / 2
HDU/ICU	• High dependency patients frequently require assessment and urgent transfer to the Paediatric ICU • Schiehallion patients can often be accommodated on ICU, requiring doctors to regularly visit this area.	1
Outpatient Department	Both patients and staff can have multiple visits between the Day-care Unit and OPD on a daily basis.	3
Patient / Family Facilities inc. refreshments ; car-parking; telephone etc.	Given the LOS of some patients, and the frequency of visits, it's essential that good quality facilities are conveniently available for both planned and unplanned visits.	3
Radiology	Patients regularly / frequently attend radiology as part of either their Day-care or In-patient investigations and treatment	2
Theatres	Most patients have several visits to theatre for surgery, biopsies, central lines, bone marrow / trephines, lumbar punctures etc.	2

*1=Essential adjacent *2 = Important 2 minutes walking *3 – Desirable 5 minutes walking

3. ACTIVITY

Activity Summary

Based upon all the above calculations, the summary of activity is given as follows:

Activity	2006/07	2013 projections
Outpatients New	158	174
Outpatients Return	7160	7870
Outpatients New (Benign Haem)	61	61
Outpatients Return (Benign Haem)	1130	1130
Day Surgery	1000	1100
Day Case/Day Care	1258	1384
Inpatients episodes	1238*	1364
Inpatients bed days	7212**	7933

***476** = elective **762** = emergency

****3336** = elective **3876** = emergency

Not included are 600 ward emergency ward attendances out of hours.

4. TRENDS

1) Of note, across all haematology and oncology specialties, greater priority has been given to developing packages of care as opposed to single treatment episodes.
This means that greater numbers of staff are involved in less frequent patient episodes, making the patient pathway much more manageable for the child and their family.

2) There has been, over the past few years, greater emphasis on the quality and quantity of cancer research documentation. Within the existing unit, there is a small, dedicated data management facility, however, it could be anticipated, that based on experience of the past five years, that this will expedentially increase in line with new case activity.

3) There has been a positive drive by the Scottish Executive Health Department, and National Services Division, to provide the necessary resource to improve the quality and quantity of Cancer Services on a local, regional and national basis over the past 18 months. This trend is set to continue over the next 18 months.

4. HOURS OF SERVCE

Current Hours of Service

Day-Care Unit

The day-care facility is open for patient care from 08:30 until 19:30, Monday to Friday. The unit remains open on public holidays, with the exception of Christmas Day and New Years' Day. Patients remaining in the unit after 17:30 are there to complete chemotherapy, blood transfusion, recovery post general anaesthetic etc. Direct emergency admissions (i.e. by-passing the Emergency Department) are accepted into day-care at all times Medical Cover is available.

Outpatient Facilities

Outpatient facilities are provided within the centralised outpatient department (OPD). opening hours are 09:00 – 17:30, Monday to Friday (excluding public holidays).

Clinics take place within these allocated sessions, within dedicated rooms.
There is no proposal to change the timings of these arrangements at present, however, with the introduction of a newly dedicated adolescent cancer service, it may be prudent to investigate early evening clinics for the benefit of our patients.
Following preliminary discussions with the Outpatient Management team, this is viewed as achievable.

6. WORKLOAD INDICATION (weekly)

Area of service	Type of Activity	Current workload	Projected workload
1) General Inpatient Ward	Daily ward rounds / diagnostic testing / patient communications / treatments / monitoring	24 / 7	No change
2a) Teenage Cancer Trust Ward	Daily ward rounds / diagnostic testing / patient communications / treatments / monitoring	24 / 7	No change
2b) Teenage Cancer Trust Day Care	Diagnostic testing / patient treatment / patient observation / unplanned admissions	08:30 – 17:30, medical and nursing cover	No change
3) Day Care Unit	Diagnostic testing / patient treatment / patient observation / unplanned admissions	08:30 – 19:00 (16 medical staff sessions)	There is a potential for an increase in nursing provision, given the move towards more home based / day care treatments, rather than in-patient care (this would equate to approximately 1 wte)
4) Clinical Administration	Patient case notes and general medical administration	All medical staff have existing administration sessions allocated within their job plans	No change
5a) Outpatients	Consultant led clinics	9 sessions	Potential for +1 session (dependent on NSD bid outcome)
5b) Outpatients	Nurse led clinics	0 sessions	Potential for +4 sessions (dependent on NSD bid outcome)
Theatres	Doctor led list	2 sessions	No change
Theatres	Nurse led list	1 session	Potential for +1 session (dependent on NSD bid outcome)

NB: Where sessions have been mentioned, this equates to 4 hours for medical staff and 3.75 hours for nursing and administration staff.

7. KEY OPERATIONAL POLICIES/ISSUES

Accommodation requirements:

1) General In-patient Ward

The ward should be accessed by entry through a double-door barrier system, which allows the entire ward area the benefit of low positive pressure ventilation. Because of the risk of infection to patients, this does mean that no exterior ventilation (opening windows or doors) can be permitted, and therefore, it is an essential requirement to have good quality, adjustable mechanical heating and cooling ventilation. A preference would be to have individual cubicle adjustable thermostats.

2) Teenage Cancer Trust ward and Day-Care Facilities

The preference, and clinical sensibility would be for the teenage cancer trust ward unit to sit alongside (in an adjacent wing or corridor) to the main haematology and oncology unit. This would allow a greater flexibility in the utilisation of specially and specifically trained clinical staff.

3) Day-Care Unit / Short Stay Ward (incorporating the Regional Haemophillia Unit)

It is not necessary to maintain a low level of positive pressure within this area, however, it is important to maintain excellent levels of heating and cooling, as patients are often unable to regulate their own temperatures.

4) BMT Waiting Room

This is a FACT-JACIE accreditation requirement. The room must be physically separated from the standard waiting room, and provide a level of isolation for the patient and their family (up to five people to be accommodated).

5) Standard Day-Stay Ward

There will be 4 bed + 2 chair day-stay ward, which can accommodate up to 6 patients, their families and appropriate staff members. The ward should include the following:

6) BMT Day-Stay Ward

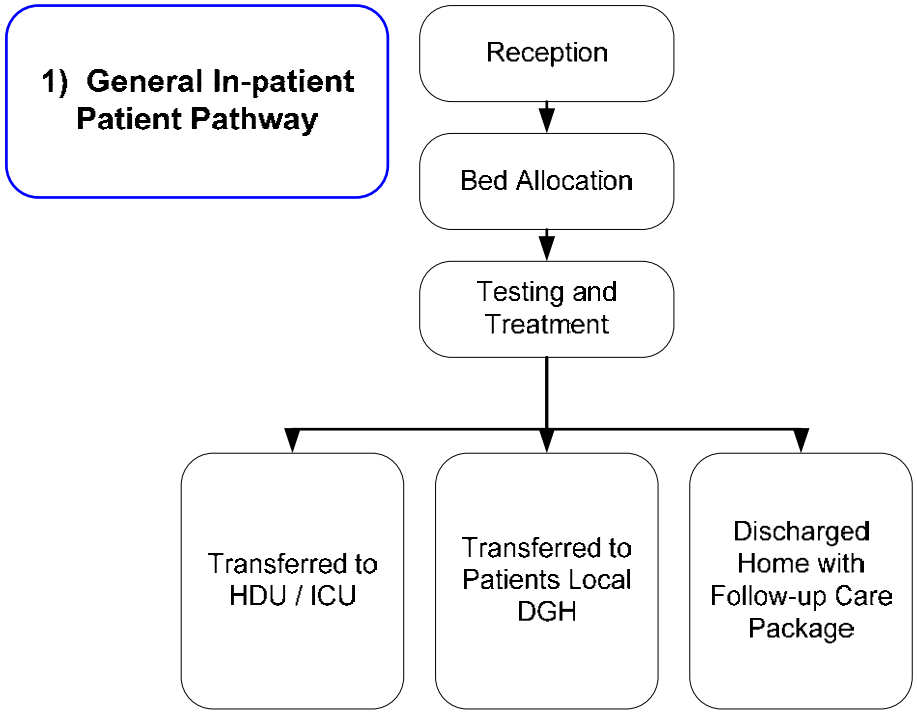
Our BMT Day-Stay Ward is suitable for up to four patients (1 trolley and 3 parker-knoll chairs). The ward should be co-located, but separate from the day-stay ward (to comply with JACIE requirements).

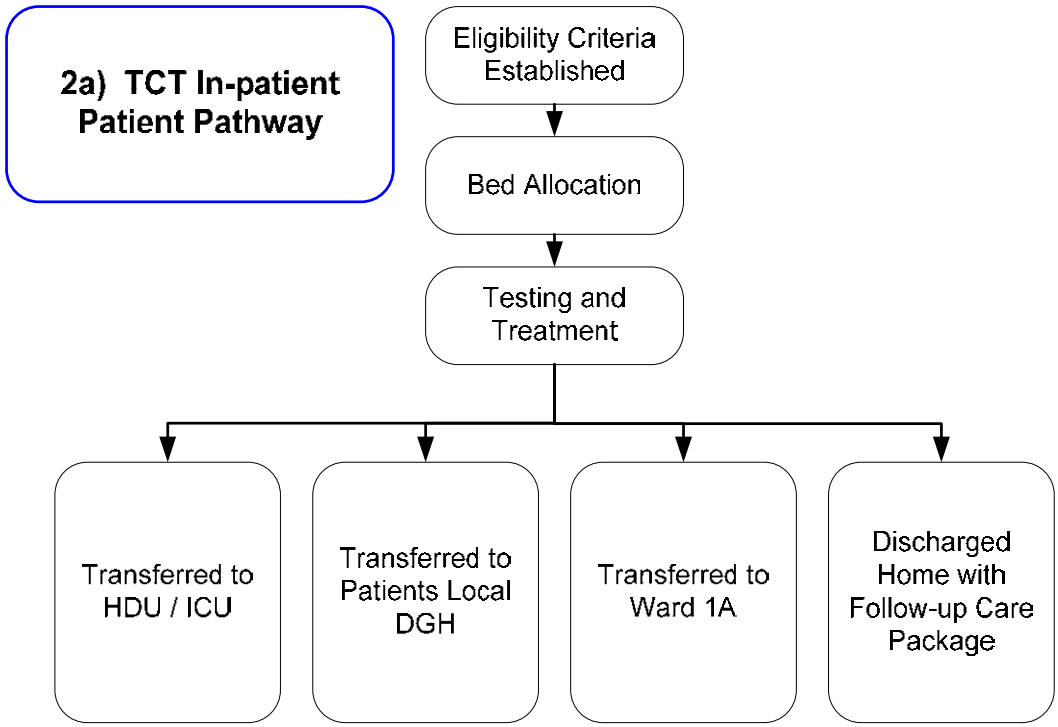
The BMT ward requires exactly the same considerations as the Standard Ward, with the addition of the entry doors being half-glass for observation. No en-suite toilet is required

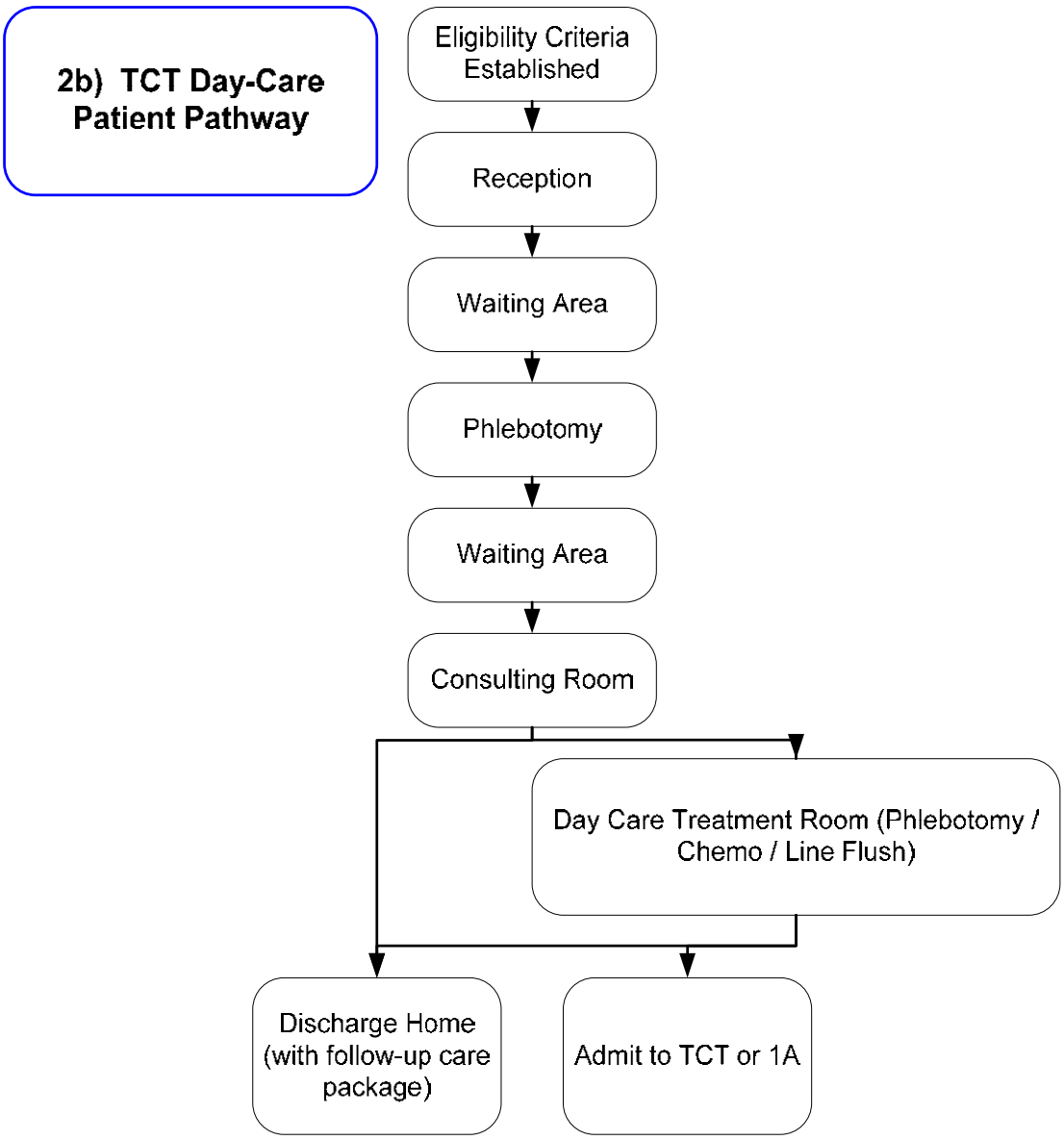
7) OPD

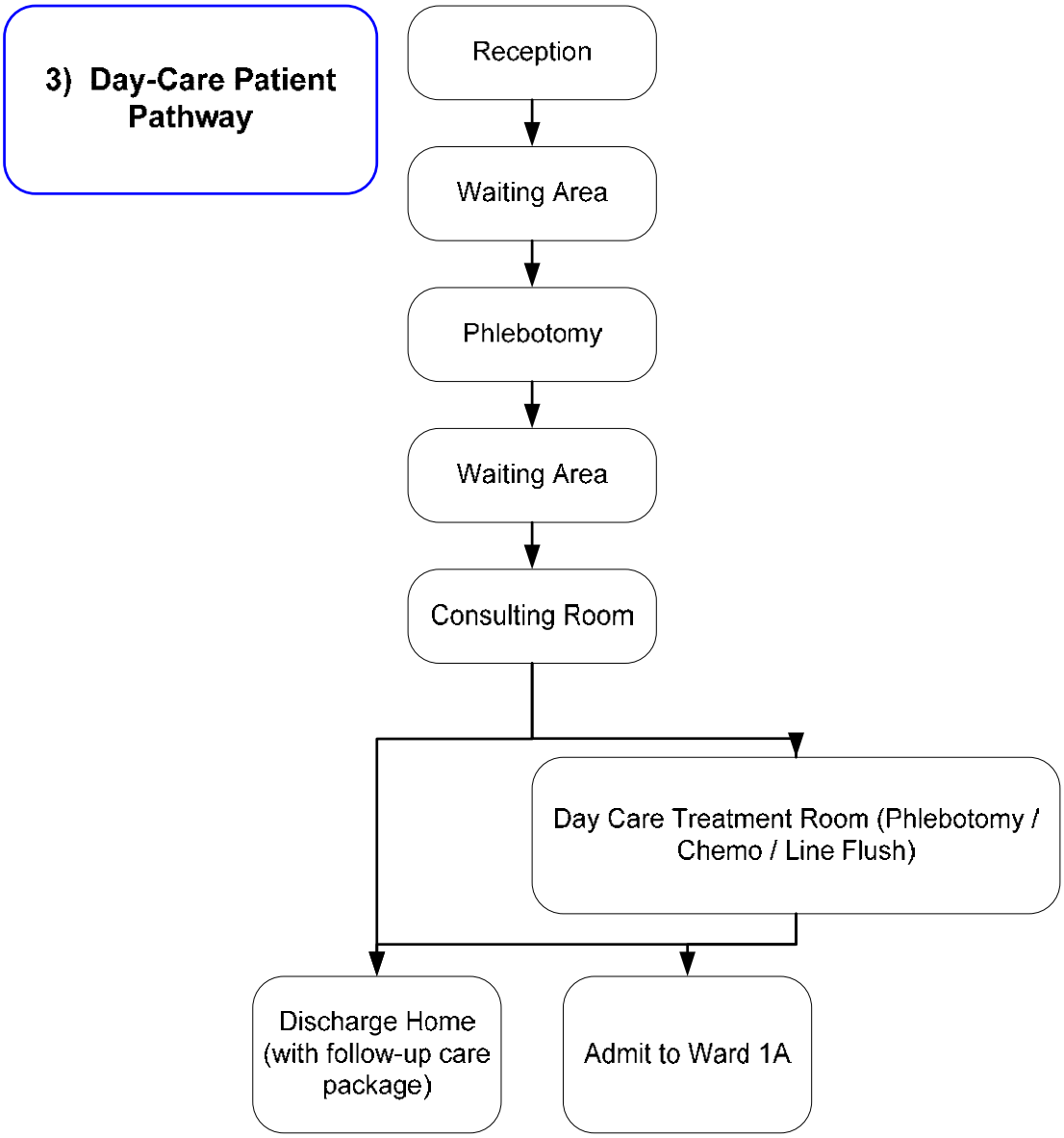
New guidance has been received (PCT – Gateway 10780, Childrens Cancer Measurement Section 08-7B-106) stating that Haematology and Oncology clinics should be spatially and temporally separate from other non-cancer clinics. This should be taken into consideration at design stage. Following these guidelines indicates that 7 rooms would be required for the on-treatment clinics.

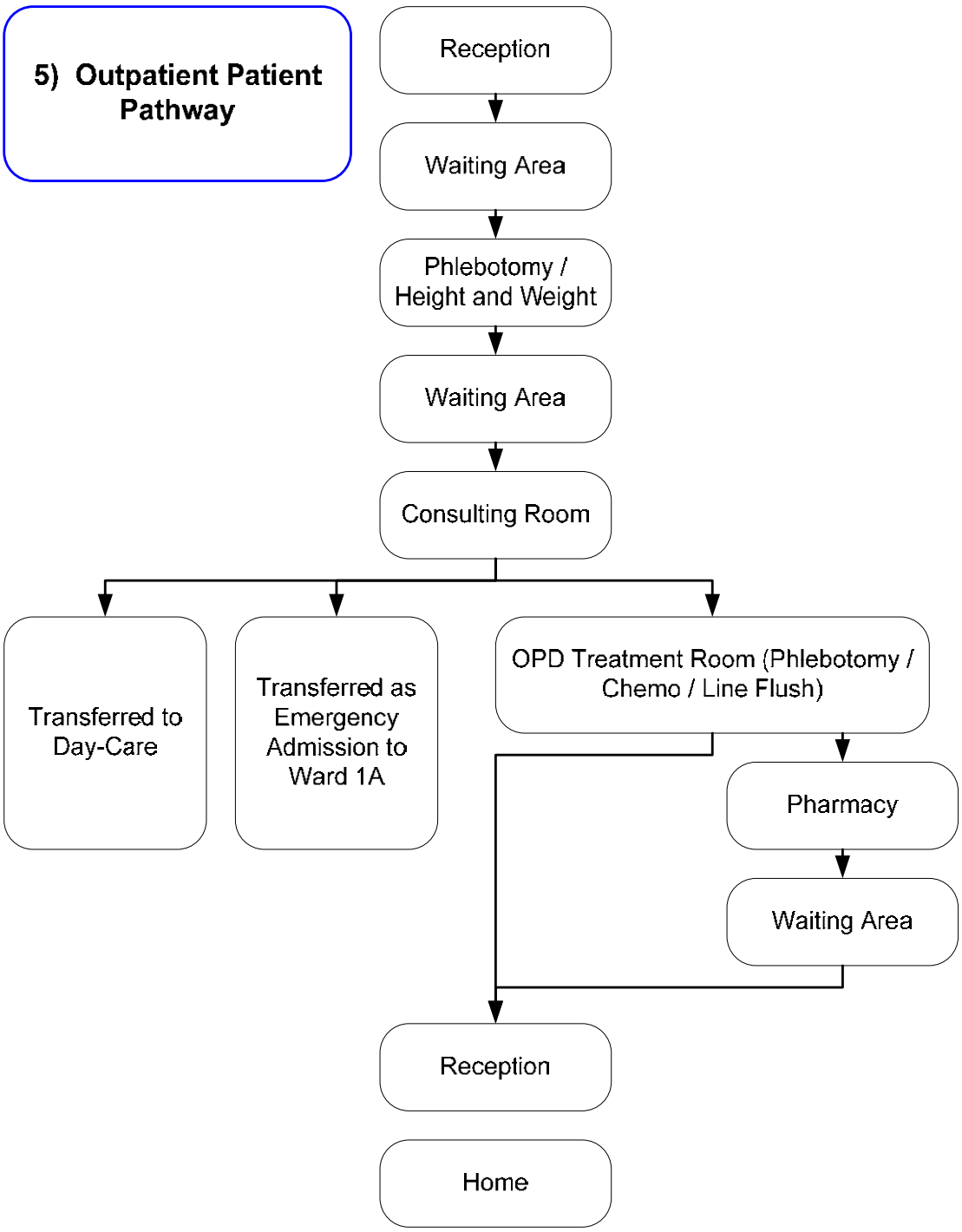
Patient pathways have been presented as representation of a typical patient journey. Due to the condition, patient packages of care will be moderated to fit the individual childs' needs.






2b) TCT Day-Care Patient Pathway
Eligibility Criteria Established
Reception
Waiting Area
Phlebotomy
Waiting Area
Consulting Room
Day Care Treatment Room (Phlebotomy / Chemo / Line Flush)
Discharge Home (with follow-up care package)
Admit to TCT or 1A


3) Day-Care Patient Pathway
Reception
Waiting Area
Phlebotomy
Waiting Area
Consulting Room
Day Care Treatment Room (Phlebotomy / Chemo / Line Flush)
Discharge Home (with follow-up care package)
Admit to Ward 1A


5) Outpatient Patient Pathway
Reception
Waiting Area
Phlebotomy / Height and Weight
Waiting Area
Consulting Room
Transferred to Day-Care
Transferred as Emergency Admission to Ward 1A
OPD Treatment Room (Phlebotomy / Chemo / Line Flush)
Pharmacy
Waiting Area
Reception
Home

There are a number of registration and clinical best practice guidelines available regarding the design and management of both paediatric and adult clinical facilities for patients with Cancer.

Most notably, our accreditation with certain regulatory bodies, dictates that some of our facilities, must be maintained, to allow our registration to continue. Amongst those we include:

- FACT – Jacie
- Human Tissue Authority
- Regional Haemophilia Centre

Recent guidance on Outpatient facilities has been documented within PCT – Gateway 10780, Childrens Cancer Measurement Section 08-7B-(100 – 113).

8. EQUIPMENT

n/a

NEW SOUTH GLASGOW HOSPITAL

Clinical Output Specification

AREA	RENAL DIALYSIS UNIT

1. INTRODUCTION

Acute Services Review: Provision of Renal Services

Although the incidence of kidney failure has remained static in Scotland for the last few years, its prevalence is rising as new patients are added to renal replacement therapy programmes [1]. A dramatic increase is expected in the coming years, driven by a range of factors including:

- An increase in Type 2 diabetes
- The ageing population
- Increasing co-morbidities
- An increase in ethnic minorities (South Asian, African and African Caribbean)
- An increase in patients from socially deprived populations [2] and possibly
- Disabled patients.

Together with the continued shortage of kidneys for transplantation, the expansion of renal replacement therapy (RRT) is mainly in dialysis. Peritoneal dialysis has not grown in recent years and most expansion has consequently been in haemodialysis (HD), delivered increasingly in renal satellite units (RSU's).

In general these RSU's are 'nurse run' renal units, which provide chronic haemodialysis but that are linked to main renal units at which nephrologists, inpatient services and interventional facilities are based. They are more geographically accessible, reduce travelling time and may be more acceptable for patients.

The present dispersion of renal services throughout Greater Glasgow will be brought together into a major renal centre at the new South Glasgow Hospital. It will be the major renal centre for Greater Glasgow and the west of Scotland. The inpatient hub will serve the renal clinical network of Forth Valley, Greater Glasgow and Clyde, plus tertiary renal referrals from western Scotland and beyond – principally for acute transplantation. In addition to this, SGH will provide renal dialysis services for patients with chronic renal failure. Thus, the major inpatient service (identified in a separate Clinical Output Specification [COS]) will be complemented by a 30 station outpatient dialysis unit. This unit will be linked to the inpatient centre and thereby be able to transfer patients from the dialysis unit for additional support when needed, e.g. a new or potentially unstable patient.

[1] Renal Disease in Scotland: A strategy for future management. April 2004
[2] National Service Framework, Renal Services, Part 1: Dialysis and Transplantation, Jan 2004 DoH

This COS deals with this 30 station renal dialysis unit component of the renal service and refers to the accommodation specified in the project's Schedule of Accommodation in the section entitled "dialysis outpatients".

The Services provided include:

Renal replacement therapy (RRT) is a life saving treatment for patients with end stage renal failure. The two treatment modalities are transplantation and dialysis (HD). Dialysis occurs mainly in hospital or RSU's with most patients requiring three times a week dialysis for approximately 4 hours at a time.

The Renal Satellite Unit provides a convenient, local service to stable, healthy and mainly ambulant adult dialysis patients, suffering from chronic renal failure. Some patients may have a physical or sensory handicap. New established renal failure patients may also attend. They require maintenance dialysis and will either reside within the local catchment area of the new hospital or find this location more accessible. i.e. The satellite dialysis unit represents a DGH function within the NSGH facility.

These patients will have access to the highly specialised treatment provided in a main inpatient renal centre.

In addition to providing dialysis services, the unit will also teach patients to carry out continuous ambulatory peritoneal dialysis (CAPD), automated peritoneal dialysis (APD) and how to operate dialysis machines for home dialysis and home care.

Care is provided by specialist renal nurses with visiting medical staff and supported by specialist technical staff that maintain the dialysis machines.

The Services provided exclude:

Children under the age of 16 who will be cared for through the paediatric service provided in the Children's Hospital.

2. LOCATION AND LINKS

Key components of the renal dialysis outpatient facility include:

- Entrance, reception and waiting facilities with associated WC's and beverage facilities
- Counselling, interview, consulting / examination and treatment facilities (30 stations plus training /treatment rooms and an information centre)
- Clinical support facilities including staff bases, clean and dirty utility rooms
- Visitors and patient support facilities including pantry, separate changing facilities, shower and WCs
- Staff changing areas including shower and WC facilities
- Staff support and education facilities including seminar room
- Storage facilities for equipment, disposables and renal consumables.
- Support facilities for equipment maintenance, workshops and repair

The satellite unit consists of three main zones:

- Patient – treatment stations
- Associated support facilities
- Staff areas

Staff must be able to see and hear patients in the dialysis area. A balance needs to be struck between adequate observation for staff and privacy for patients.

Utility areas and equipment storage maintenance areas should be located to provide ease of access to patient – treatment stations and to the treatment room for inserting lines, dressings etc.

Staff rooms and offices should be separate from, but close to, patient treatment stations.

Ideally, the layout of the 30 bed multi-station dialysis area should optimise the opportunities for patients to talk to one another and nurses. Although the preferred configuration for all treatment stations would be to see as many as possible provided in 4 place open/shared “bay” areas, this is still the subject of discussion with infection control. Consequently these areas ie (4 places) are assumed to be open front cubicles with patients separated by floor to ceiling glass walls.

A 2.5m unobstructed corridor space is required beyond the working area and even if, following conclusion of discussions with infection control, the area is configured as open plan rather than 3 walled cubicles, it should be capable of being converted into cubicles (with fixed glass walls) at some time in future without disruption to any services.

The present configuration sees:

- 20 spaces (notionally for chairs rather than trolleys) as described may be in bays of ideally 4 open front cubicles. NB It may be possible to reduce the areas allocated if an open configuration is agreed

- 6 further spaces for trolleys in open bays
- 4 spaces configured as rooms

The workshop and maintenance areas should be close to but not part of the treatment area. (Please see the description of these facilities in the renal wards COS)

Recognising the high expected utilisation of the unit, its design should encompass a soft expansion plan for additional dialysis spaces – e.g. if Seminar Room is adjacent to treatment area it could allow for conversion into further stations.

The satellite dialysis unit should be within close proximity to the renal services within the acute hospital (i.e. not at the far end of the site) with its own dedicated entrance route. Good staff and patient routes between the inpatient unit and the dialysis unit, however, are more important than a ground floor location. There must be a clear simple route for patients from the main entrance to the dialysis unit.

The entrance to the dialysis unit, which operates a 24 hour service, must be prominent with secure entry systems.

As patients may travel by taxi, ambulance or private car, it is important to provide dropping off points for ambulances, and dedicated 'disabled' car parking spaces, immediately adjacent to the unit, or the hospital main entrance if this is the route to the unit. The entrance to the unit (or hospital main entrance) should be covered so that patients transferring from a vehicle into the unit are not exposed to the weather.

Close to	Reason	Category*
Inpatient renal services	Staff and patient flow	2
Main Entrance	Patient Support	1 (but lift + short route acceptable)

*1 = Essential adjacent
*2 = Important 2 minutes walking
*3 = Desirable 5 minutes walking

3. ACTIVITY

Activity	Current Activity	Future Activity
Outpatient haemodialysis	30 stations operating 3 shifts per day, 6 days per week, 52 weeks of the year.	30 stations operating 3 shifts per day, 6 days per week, 52 weeks of the year.
Outpatient Peritoneal Dialysis	1 – 3 patients per month trained as an outpatient to deliver their PD treatment at home – Monday to Friday, 52 weeks of the year.	1 – 3 patients per month trained as an outpatient to deliver their PD treatment at home – Monday to Friday, 52 weeks of the year.

4. TRENDS

Given that the incidence in end-stage renal failure rises sharply in people over the age of 80 years, and that some ethnic minorities have a higher prevalence of conditions, which can cause end stage renal failure, it is expected that the need for dialysis will continue to rise. Additionally with the shortage of suitable donor organs continuing, it seems likely that the demand will not fall for this reason. Those patients who are successful in receiving a renal transplant may suffer rejection, some even requiring a second or third graft over several decades, with further periods of dialysis in the intervening years.

Experiments using animal kidneys are underway, however it will be some time before we know whether xenotransplantation will contribute to the transplant programme and help reduce the pressure on long-term dialysis. Current proposals by the Government to promote the potential availability of transplantable organs would definitely impact on the demand for dialysis, however it may be many years before such a strategy is implemented or shows results.

To promote overall improvements in the provision of renal services and the associated quality in care provision Managed Clinical Networks (MCN's) are being established.

5. HOURS OF SERVICE

Current Hours of Service:

The unit will be open 24 hours Monday through to Friday. On Saturday, the unit will close at 19.30, re-opening on Sunday at 19.00.

A shift system will be in operation.

6. KEY OPERATIONAL PROCESSES / ISSUES

Care Model

The service is delivered by a group of specially trained renal nurses and medical staff, together with technical and clerical staff. Although it will be a relatively autonomous unit, the nurse consultant reports to his/her line manager in the main renal centre. An individual care plan is devised for each patient.

It is assumed that patients will have had a fistula formation prior to commencing the dialysis programme.

The approach is holistic and is a combination of nursing and medical models.

The daily workload is generally predictable as patients attend using an appointment / booking system and it is the aim that all patients commence dialysis within 30 – 60 minutes of arrival [3]. There are however, occasions when complications of dialysis develop e.g. patients' blood pressure falls, they have a dangerously high potassium level requiring treatment, they suffer a cardiac arrest and require resuscitation, etc.

The standard care pathway would progress as follows:

- Patients arrive at the reception area and are received and registered. They wait in the waiting area until a dialysis machine is prepared and ready for use.
- They are transferred to the physical measurement area where they either take their own blood pressure and weight or request assistance to do so (systems are available that electronically transfer data to the dialysis machines via smart cards). Some patients may change into loose comfortable clothing prior to commencing dialysis
- At the treatment cubicle dialysis chair or bed, blood tests are taken and the patient is linked to the dialysis machine. It is not necessary for the patient to remove any of their clothes, merely to ensure the access for dialysis is visible. Treatment generally lasts four to five hours, but varies according to individual needs. In that time patients may watch television, listen to music or eat any

[3] Standard 13, Adult Renal Services Standards, February 2002.

snacks / light meals they have brought with them. Toast, biscuits, sandwiches and drinks etc are provided from the Unit Pantry.

- The patient's temperature, heart rate and blood pressure is monitored during the treatment. Blood tests may be taken at the end of the procedure particularly if there is concern that a satisfactory dialysis may not have been achieved.
- Following treatment either the patient monitors their own blood pressure and weight or it is done for them. They retrieve their possessions, confirm their next appointment and leave the unit or wait until transport arrives.

It is noted that:

- Some patients may have an appointment with medical staff, which will be accommodated for in their treatment time.
- Patients who require dressings will have this undertaken by the nurse either before or after treatment.
- If line changes are required the nurse will ensure that this is carried out when medical staff are available and the procedure will be booked accordingly.
- New dialysis patients or those who have lost their access (fistula) will require booking into the interventional radiology suite for fistula preparation/renewal. Nursing staff will arrange this.
- Further support for patients is available in the form of dieticians, social workers, specialist nurses, counsellors and pharmacists etc e.g. the whole multi-disciplinary team; this can either be arranged at a dialysis session or at an OPD clinic.

Patient should be collected by transport within 30 – 60 minutes of completion of their dialysis session[2].

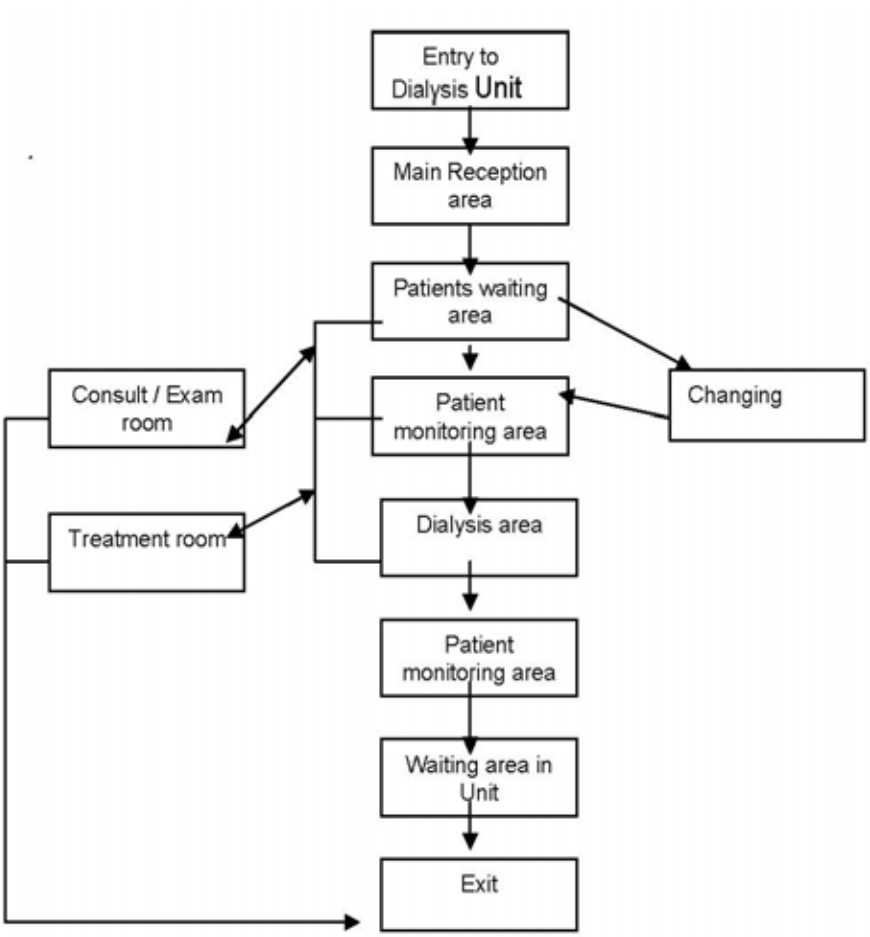
It is further noted that information management and technology is fundamental to the successful operation of a dialysis unit and systems should be capable of handling:

- Management information, including clinical audit
- Materials/stock management
- Information management, including feedback from patients
- Referrals and appointments
- Test/investigation ordering and results access/management

The provision of the right information at the right time is essential to support the needs of patients with renal failure. Consequently national programmes e.g. Renal Information Strategy seek to ensure that information infrastructure, systems and services are developed to do this.

Patient / Process Flow & Service Delivery

Following referral from a nephrologist and acceptance onto the dialysis programme the pathway for dialysis is as follows:



Design Requirements & Guidance

Renal services should be centred on the needs of patients with established renal failure and designed to facilitate their 'journey'. Wherever possible, dialysis should be delivered at a time and place convenient for patients and in an environment that is clean and comfortable. The design must be flexible enough to cater for all genders, cultures and ethnicity and it should also treat patients with respect and dignity.

Additionally, consideration should be given to alleviating fear and anxiety, maximizing security and safety, reducing boredom and creating a healing environment. Furthermore well-designed furniture and fittings should be considered.

Imaginative use of floor and wall finishes, colour and lighting will help to produce a warm, friendly environment.

Water treatment should reach a minimum of the following standards:

- The higher European Pharmacolela (EP) XV1 standard :'Water for diluting concentrated haemodialysis solutions'
- ISO 13959: 'Water for haemodialysis and related therapies' or
- AAMI (Association for the Advancement of Medical Instrumentation) standards

- European Renal Association Best Practice Guidance – 4th Edition 2007. NB New guidelines are due in 2009 and should be considered at that time.

It is advisable that in preparing water specifications for water treatment plant the advice of the local water board should be sought, a renal technician, specialist water treatment companies and equipment manufacturers. It should also be noted that it is envisaged that water treatment plant will meet the needs of inpatient areas and the new Children's Hospital, Maternity and Neurosciences buildings, as well as the dialysis unit.

Please refer to generic schedules of the project documentation for overarching design requirements and guidance.

Specific attention is drawn to the design guidance contained in the separate guidance documentation.

Designers should create an environment that will help patients feel at ease, be conducive to efficient working, and contribute to staff morale. This is particularly important in the dialysis area where patients spend so much time. External landscaping is often of special value.

An acceptable range of temperatures during dialysis is important for patient stability and well being. The extent of ventilation required is dependant upon local heat gain within the dialysis area and the provision of climate control is a consideration.

The dialysis area should have plenty of natural light and an outside view. Artificial lighting can make an important contribution to the interior design and should mimic natural lighting as far as possible.

Consideration needs to be given to the provision of an entertainment system with individual TV, headphones etc and a telephone handset that allows patients to both make and receive calls. Televisions may be suspended from ceilings, wall mounted or with swing out arms with individual headphones to avoid disturbance to other patients. Consideration should also be given to providing internet access data points or wireless connection for those patients with laptop computers.

Medical gases to include oxygen and suction at each station is required.

The aim is to humanise the surroundings and improve experience and physical surroundings.

ROOMS & SPACES REQUIRED

All rooms are listed in the SofA. This section therefore only refers to rooms that have a unique function within the renal environment.

Unique Rooms & Spaces Required - Descriptions

Reception & Office – 6 staff

An office is required at the entrance to the unit and adjacent to the waiting area for receiving and registering patients upon arrival and to act as the administrative and communication centre. A welcoming open plan layout allows reception staff to see and receive patients entering the unit and promotes effective communication between patients, escorts and staff. The reception office should be accessible to people in wheelchairs and the counters or reception desks must be such to as to

ensure that patients in wheelchairs can communicate with staff at terminals. Consideration should be given to routing all telephone calls to and from the unit through the reception office.

Workstations, computers and photocopying facilities will be required as well as a fax machine for transmitting messages to the main renal unit, general practitioners and other personnel. Cupboards will be required for storing a working supply of stationary, information leaflets etc.

From the reception area it should be possible to visually check persons entering, for security reasons.

Physical Measurement area x 3
This space is used to monitor a patient's blood pressure and general health prior to each dialysis treatment. Data may be recorded either on a computer or on paper. Facilities required include: chair weighing scales and wheelchair weighing scales, a desk, chair and storage for blood pressure equipment (manual or electronic). A CHWB, accessible by wheelchair patients, will also be required, as patients will need to wash their fistula arms before treatment. There should be sufficient space to accommodate a nurse, on patient, a helper and wheelchair scales.

Treatment Cubicle/Equivalent Space: dialysis, 1 patient x 20
The dialysis area may consist of dialysis stations arranged in modules taking into consideration the needs of staff communication with groups as well as plumbing and electrical needs. In choosing chairs, a consideration is that chairs could be modified so that they may be used as cycle machines for exercise for patients whilst on dialysis. Sufficient space must be allowed for the chair to be fully reclined and for nurses to carry out all procedures. Treatment stations need to be arranged so that patients can be attached to the machine by either arm or by cannulae in their neck or groin (dependent upon access). One emergency call button (with audible and visual alarm) should be provided.

Attention is also drawn to the earlier comments related to infection control issues and the debate around open areas vs cubicles. It is noted however that, if areas were configured as open spaces, that no more than 8 spaces should be located within the same bay in order to support "cohort nursing" and reduce the risk of cross-infection. (Ideally bays will contain 4 spaces/cubicles)

Storage space is required at each station for frequently used medical items and for patients to carry out activities e.g. watching television whilst undergoing dialysis. Easily reached storage shelves are required for staff use. Dialysis chairs with integrated tables are required for patients. The need for a computer outlet, telephone point and network connection point at each station is a consideration as well as computer data points for staff. One CHWB is required between two stations, with:

- Alcohol hand rub
- Wall mounted soap and scrub dispenser, aprons and gloves
- A towel dispenser
- Clinical and non clinical waste bin
- A sharps container

Treatment Cubicle: dialysis, 1 patient x 6

These spaces are identical to the cubicles above except that they are large enough to accommodate a bed.

Isolation treatment room: dialysis, 1 patient x 4
These rooms have the same equipment as a standard treatment station but with the addition of hand wash facilities for each bedroom, rather than sharing. The room should allow for either a bed or chair. They cater for patients who may have Hepatitis B or C, HIV, MRSA or other infectious conditions. The rooms should be accessible from the main dialysis area with viewing windows. The door to each room should be kept closed as much as possible to reduce the disruption of the required airflow. An emergency button is required with auditory and visual alarm. One or all of these rooms may also be used for 'routine' treatment if all other stations are occupied. Each room should have a dedicated CHWB.

Training room & office: Peritoneal Dialysis (PD)
There should be facilities for teaching patients how to perform a variety of tasks including CAPD and APD and how to operate haemodialysis machines for home dialysis and self care. Training should take place in an informal, non-clinical environment that relates more to a patient's home environment. The space should accommodate a nurse, two patients and two escorts as well as a sink for disposal of saline solution and other waste products. A bag warmer is required and facilities to operate an automated peritoneal system should also be provided. A variety of cupboards and shelves for the storage of CAPD equipment and other stationery and office supplies is required. The peritoneal dialysis nurse will require a workstation and computer terminal. This room or a consult / exam room could be used if patients 'drop in' for advice and information.

2 x Patient changing room: 15 places
Separate male and female changing rooms and lockers are required where patients can change into comfortable clothes prior to dialysis and store their outdoor clothing and personal items whilst on the dialysis machines. A variety of lockers and hanging rails are required for secure storage

Store: furniture, equipment & disposables
This large store (40m2) is for equipment (chairs, drip stands etc) and for disposables

Store: equipment & renal consumables
This store is large with adequate racking. Its size (25m2) assumes that supplies are delivered frequently. It should also contain a bottled gas rack.

Renal Technology Area (Workshop: renal dialysis equipment)

A workshop is required for the maintenance and repair of dialysis machines. This space should be sufficient to park and manoeuvre equipment and accommodate a workbench with integral lockable cupboards. A computer terminal is required to record all services and repairs on a central database. Manufacturer's user manuals may also be located here. A CHWB, a hand washbasin and a sink for cleaning components and disposal of non-toxic waste should be provided. Alternative disposal should be available for contaminated waste. The component areas of this suite of rooms are:

- Equipment Servicing Area
- Live Test Area
- Ready Use Equipment / Out Lobby
- Component Store

NB The space identified within the satellite unit SofA (95m^2) is to service the whole renal service (including in-patient areas). (Please refer to the more detailed description of this area within the renal wards COS)

7. EQUIPMENT

Key elements of the renal service's requirements are identified throughout this document and in related COS's and output specifications.

The dialysis unit will require large volumes of clinical and non clinical supplies to be delivered and therefore large volumes of waste will require collection. The FM strategy must take account of the logistics and frequency of deliveries / collections.

It is envisaged that, as in the exemplar design, that water treatment plant and storage facilities will serve inpatient areas as well as the dialysis unit.

NEW SOUTH GLASGOW HOSPITAL

Clinical Output Specification

AREA	RENAL DEPARTMENT

1. INTRODUCTION

The present distribution of renal services across Greater Glasgow will be brought together into a new major renal centre at the new South Glasgow Hospital (SGH). This facility will be the inpatient hub for the renal clinical network of Forth Valley, Greater Glasgow and Clyde. It will also support tertiary renal referrals from throughout Western Scotland and beyond – principally related to acute transplantation. In addition to acute renal and nephrology services, it will also provide renal dialysis services for patients with chronic renal failure.

The Greater Glasgow population will receive the full range of services from the SGH renal centre. The tertiary service provided will accept referrals, including transplant surgery, from the western half of Scotland.

This Clinical Output Specification (COS) deals with the major renal service component that supports:

The renal transplant service
Inpatient medical and surgical care for renal patients
Level 2 renal care
Acute medical assessment of renal conditions/problems
Day case services
Assessment and triage
In-patient dialysis support

This accommodation is as specified in the project's Schedule of Accommodation (SofA) in the section entitled "renal wards".

The Services provided include:

The renal department is an integrated service providing inpatient care to elective and emergency patients suffering from renal disease and its complications, including acute onset renal failure, chronic renal failure and end stage renal disease. Many patients cared for are acutely ill (requiring level 2 care) with associated co-morbidities and social needs.

The service will also support the needs of inpatients under the care of other specialties who have established renal disease and who may require treatment and renal support during their episode of inpatient care.

Patients on established haemodialysis will be treated in the dialysis satellite unit. (See separate COS)

The inpatient service provides kidney support (including haemodialysis) and transplantation services (including workup, surgery and post-surgical care). It also supports the management and treatment of the physical manifestations of kidney disease, e.g. hypertension.

As well as meeting the needs of the local adult population of Greater Glasgow, the renal facility will also provide a tertiary service to the population of the West of Scotland related to the support/early management of emergencies resulting from renal replacement therapy, the management of chronic renal disease, acute renal failure and routine nephrology.

The service also supports outreach clinics at a number of District General Hospitals (DGH's) throughout Western Scotland, with the facility at the Southern General also acting as the main hub or 'mother' centre for renal satellite units (spokes) in Forth Valley, Greater Glasgow and Clyde.

In addition, renal clinicians also provide structured support to other specialties at SGH, such as vascular, diabetes, haematology, neurosciences and critical care. They also frequently provide support to patients/clinicians in other areas such as plastic surgery and infectious diseases, sometimes in other centres and without the patients necessarily coming to the SGH.

Overall the department focuses on the prevention, early intervention in and education related to renal disease across the population.

The Services provided exclude:

Specific exclusions from this service include:

Children under the age of 16 who will be cared for through the paediatric service provided in the Children's Hospital.

Adult patients requiring level 3 care, who will be cared for in the Critical Care Facility (CCF). (See Critical Care COS for details)

Adult renal patients in other critical care units outwith the scope of this document/programme, e.g. Cardiac surgery.

Scheduled Outpatient Services.

2. LOCATION AND LINKS

2.1 CLINICAL FACILITY REQUIREMENTS

Major components of the accommodation include 80 inpatient beds, day area and 4 bay dialysis area. These are described in the schedules as below however they will be combined within a continuous space to achieve optimum nurse staffing.

- 2 x 22 bedded wards
- 1 x 16 bed ward and day unit
- 1 x 20 bed higher acuity (Level 2) ward

This accommodation should be located together, recognising the need to support integrated care models whilst minimising unnecessary staff and patient movement.

It should be noted that all bedrooms in all wards should be plumbed for haemodialysis.

2.1.1 Two 22 Bed Wards

Although listed as 2 x 22 bed wards for historical reasons the configuration of these bedded areas may be able to flex to support the overall design.

These wards are all in single, en-suite rooms as described in the Generic Ward COS with the following key differences:

- The provision of dialysis support infrastructure in rooms
- The number of rooms per "ward"

Two single rooms per ward will have associated gowning lobbies, for infection control purposes (source and protection)

The inclusion of a treatment room at 16.5 m2 in each ward

In addition it is noted that the SofA identifies the requirement for additional "general storage space" and 6 clinical workstations to support both 22 bed wards.

It is further noted that the IT network infrastructure should include telemetry facilities, to allow remote monitoring, for all patients in all renal wards / beds with the central monitoring station located at the main ward base. (This is noted in the Generic Ward COS but underlined here for reference)

Equipment maintenance and associated storage and testing areas will be provided for the entire renal department from a location identified within the outpatient dialysis area only.

2.1.2 16 Bed Ward & Day Unit & Treatment/Triage Area

Key components of this area include:

- 16 beds in single rooms with en-suites as described above.
- A day assessment and treatment area
- An in-patient dialysis centre
- A range of back-up, admin, utility and shared accommodation, as described within the generic ward COS, to create a single functional clinical unit

Bed Area Facilities

The 16 bed ward supplements the 2 x 22 bed wards already identified and consists of:

- 16 beds in en-suite accommodation as described above with associated en-suites as described in the Generic Ward COS

Day Assessment & Treatment Area

The Day Assessment & Treatment Area has a self-explanatory function but will also be used to support the triage of patients arriving in the renal department, e.g. from outpatient clinics. It will consist of:

A small waiting area

A minor procedures & treatment room (including prep area)

- 3 x consult / exam rooms

A 4 bed day trolley bay (Although reclining chairs may be specified as an alternative)

Disabled WC

Dedicated staff base

NB It is identified that the preferred configuration for the day trolley spaces would be to see them provided in a shared “bay” area, although this is still the subject of discussion with infection control. Consequently this area is assumed to be 3 sided cubicles with floor to ceiling glass walls separating patients with each cubicle having an open front.

A 2.5m unobstructed corridor space is required beyond the working area and even if, following conclusion of discussions with infection control, the area is configured as a space, rather than a room, and it should be capable of being converted into a room (with fixed walls) at some time in the future without disruption to any services.

Inpatient Dialysis Centre

Additionally, this ward accommodates an inpatient dialysis centre. This is accommodated in a 4 station supervised bay and includes nurse workstation and storage cupboards which are shared with the day assessment/ treatment area The inpatient dialysis centre will support the dialysis requirements of patients who may have to travel there from other areas within the hospital. It will consist of:

- 4 x dialysis stations

As noted above, these dialysis stations would preferably be configured as a single open bay although the same infection control issues arise. Consequently this area is assumed to be 3 sided cubicles with floor to ceiling glass walls separating patients with an open front.

A 2.5m unobstructed corridor space is required beyond the working area and even if, following conclusion of discussions with infection control, the area is configured as a space, rather than a room, and it should be capable of being converted into a room (with fixed walls) at some time in the future without disruption to any services.

Back-up/Admin/Utility/Shared Accommodation

A range of support accommodation is identified in the SofA to ensure that the 16 bed ward and day unit can function as an independent clinical unit. This accommodation is all primarily as described either within this document or the generic ward COS. Notable differences include:

2.1.3 20 Bed Higher Acuity / Level 2 Ward

This ward will accommodate patients requiring Level 2 care, but may include some Level 1 patients. As with all other bedded accommodation within the unit, all beds will be in single rooms. It has a number of differences to the other renal wards however. For example:

- The bedrooms are larger, to take equipment
- Only 12 of the 20 rooms will have en-suites

Four rooms will have associated gowning lobbies, for infection control purposes (source and protection) all of which will have en-suite.

Two assisted shower / WCs are available throughout the ward to support patients able to leave the bed under supervision who are not in rooms with en-suites.

An overhead pendant for multi-parameter monitoring, medical gases (oxygen and air), medical vacuum, and electrical outlets is required rather than a bed head unit. (This should be as specified for level 2 beds in HDU, please refer to the Critical Care COS for details)

Medical gases and vacuum will also be required in treatment rooms.

A visitor sitting and waiting room, with beverages, is also required

A status laboratory and an additional dirty utility, compared to the other renal wards, are required

2.2 INTERNAL RELATIONSHIPS

2.2.1 Cluster Model

A cluster model should be adopted for the configuration of the renal wards, i.e. the four wards should be clustered on one floor around a centrally positioned support core containing FM, administration and other support services. These should be configured to include a regeneration kitchen, central wash-up, disposal hold, cleaner's room, staff locker rooms, seminar / education facilities, medicines management, bulk fluids storage (surgical ward floors) and administration workstation area.

This is as described in the Generic Ward COS which should be referred to for further information.

2.3 ACCESS & KEY DEPARTMENTAL RELATIONSHIPS

In reflecting key adjacencies for the renal wards and department it is noted that co-location of the facilities identified within this COS and the associated SofA is essential.

Close to	Reason	*Category
Critical Care Area	Patient transfers from & to	2 (Particularly access to renal level 2 area)
General Wards	Patient transfer	2
Imaging	Patient journey	1 ie within short travel time
Interventional Radiology	Procedures	1 ie within short travel time
Operating Theatres	Access to theatre	1 ie within short travel time
Acute Assessment Unit	Expedite transfer route	2
Emergency Department	Expedite transfer route	2
Main Entrance (incl	Patient journey	2

Admission & Discharge Lounge)		
Dialysis Unit	Staff & Patient transfer	2

*1 = Essential
*2 = Important
*3 = Desirable

3. ACTIVITY

The beds are derived from the Pan Glasgow Bed Modelling Exercise.

4. TRENDS

The renal centre will follow the established national model of care[1] such that all inpatient renal services are provided within a discrete area, providing level 2 care and supported by a level 3 facility within easy access. This allows a patient presenting with renal disease to follow a pathway of care from presentation (that may include transplantation) in which they are cared for by a clinical group who, supported by other specialties, are able to manage the disease process and its manifestations in one clinical area. This minimises patient risk and improves outcomes.

This method of providing services will continue to be refined and developed but will not undergo essential change.

Training requirements for clinicians, nurses and AHPs are under review nationally. Access to training facilities at ward level is essential. Additional on site facilities for training will also be required.

Infection control and its requirements are likely to increase as the focus on controlling HAIs is unlikely to shift in the future, this is particularly likely to impact on the unit, particularly given its role in supporting transplant activity.

Organ donation and transplantation is currently under review nationally. It is possible that more cadaver organs will become available in future. Additionally, live donor transplant may increase.

[1] The Renal Association's publication of August 2002: The Treatment of Adults & Children with Renal Failure (3rd Edition)

5. HOURS OF SERVICE

Current Hours of Service:

All wards will continue to operate 24 hours per day 365 days per year.

The day trolley spaces will operate a 2 shift system between circa 8.30 am and 8.00pm Mon-Fri (although triage areas may be used 24 hours per day 365 days a year)

The in-patient dialysis area will primarily operate a 2 shift system between circa 8.30 am and 8.00pm 6 days/week

No scheduled outpatient activity will be delivered from the renal unit within the Southern General Hospital

These hours of service should be a key consideration in the physical and engineering design of the new facility, which should reflect the ability to "close down" non-operating services when they are not required without any impact on wider service delivery.

6. WORKLOAD INDICATION (weekly)

Care Model

The care model is 'unusual' in the current healthcare climate of specialty management, in that patients undergo medical and surgical care within an integrated facility. This model is considered to improve patient safety and outcomes as the same team manage the patient from the time of presentation, drawing on other specialty support as and when required. Thus, all co-morbidities and complications are anticipated, known and understood.

Patient / Process Flow & Service Delivery

Most patients will access the SGH service from a satellite unit, however it can also be accessed:

Through the outpatient pathway following GP referral

Via the Emergency Medical Complex (ED & AAA) (See separate COS for details)

From level 3 (Critical Care Facility) when requiring further renal support after an initial acute episode

From other inpatient specialty wards having developed renal problems as a result of their episode of care

From satellite dialysis units when requiring assessment and or admission

It is noted that some patients, dependent upon how, when and where they present from will be assessed initially within the Triage Area to determine the intervention required and where/how this can best be provided. In general:

Patients at acuity level 0 -1 will be cared for in one of the general renal wards single rooms. From here they may undergo a number of investigations, interventional vascular and other procedures, imaging, observation, diagnosis and treatment. Once

stabilised, they may then be discharged for further management in primary care or undergo dialysis (peritoneal or haemodialysis) prior to discharge.

Acutely sick patients with a high level of acuity will be admitted to a level 2 bed and managed accordingly. If they deteriorate to the point of requiring level 3 care they will be transferred to the Critical Care Area.

Many patients will access interventional radiology, cardiac testing, imaging and other diagnostic and treatment services within the hospital. Discrete routes to and from these areas, plus routes to and from operating theatres and critical care will be required.

Any patient requiring protective isolation or with a highly infectious problem (e.g. Herpes) will be nursed in a room with an associated gowning lobby.

A significant proportion of patients in established renal failure will be eligible for renal transplantation. They will follow an established work-up pathway and following transplant surgery will be nursed in a protective isolation level 2 bed (with gowning lobby). Once well enough, they will be transferred to a general bed with or without protective isolation (depending upon their immunity status). Once fully recovered and with an acceptable immune status, transplant patients will be discharged home. Follow-up will be shared between the acute and primary care providers

Inpatients on other wards who are in established renal failure and require haemodialysis during their episode of care will be dialysed in the 'day unit' associated with the 16 bed ward.

It is of note that acute renal disease frequently becomes a chronic disease process meaning that many patients will remain within the service for life, requiring recurrent inpatient episodes in support of the management of their condition.

This should have an impact on facility design and particularly finishes as the renal patient cohort will find themselves in hospital far more than any other major patient group.

7. KEY OPERATIONAL PROCESSES / ISSUES

Design Requirements & Guidance

Please refer to the project documentation for overarching design requirements and guidance.

Environmental and Services Requirements

The need for each bedroom, and dialysis bays, to be plumbed for haemodialysis should be noted, as should the provision in the dialysis unit and critical care area. (See Critical Care COS for details)

Additionally, the new Children's Hospital and existing maternity and neurosciences buildings also require access to appropriate treated water supplies. The anticipated engineering strategy is for all of these areas to be addressed by an integrated approach.
Water treatment should reach a minimum of the following standards:

the higher European Pharmacolela (EP) XV1 standard :'Water for diluting concentrated haemodialysis solutions'

ISO 13959: 'Water for haemodialysis and related therapies' or

AAMI (Association for the Advancement of Medical Instrumentation) standards

European Renal Association Best Practice Guidance – 4th Edition 2007 – new guidelines due in 2009 and should be considered at that time.

It is advisable that in preparing water specifications for water treatment plant the advice of the local water board should be sought, a renal technician, specialist water treatment companies and equipment manufacturers. It should also be noted that it is envisaged that water treatment plant will meet the needs of inpatient areas as well as the dialysis unit and Children's Hospital.

Generally, environmental and services requirements should correspond to the standards described in the relevant HBN 53 Volumes 1, 2 & 3, HTM's and other technical guidance and the technical output specification for this project.

Consideration must be given to:

The privacy and dignity of patients

The needs of disabled and the requirements of the DDA

Infection control measures

The management and disposal of contaminated waste (consider in conjunction with inpatient services)

Security and safety of staff and patients

The development of near patient testing

The comfort of patients and staff is important and keeping room temperatures low during dialysis is important for patient well-being and stability. The extent of ventilation required is dependant upon local heat gain and the provision of air conditioning is a consideration, for example in dialysis areas and Level 2 higher acuity beds.

Areas used for dialysis should have plenty of natural light and an outside view. Artificial lighting can make an important contribution to the interior design and should mimic natural lighting as far as possible.

The Whole Hospital Policy sets out common standards, such as power and data point requirements, that are to be applied throughout this project. In addition, consideration must be given to protecting the privacy and dignity of patients. Sound attenuation measures to ensure speech privacy in consult / exam, treatment, scanning and other rooms where patients and clinicians have private discussions should be provided.

The design also needs to take account of the need to create a pleasant environment for the patients and staff by means of good design, locally controllable lighting and access to natural light and views.

Rooms & Spaces Required

All rooms are listed in the SofA. This section refers to rooms that have a unique function within the renal environment.

RENAL TECHNOLOGY LABORATORY (WORKSHOP)

A Renal Technology Laboratory for the maintenance and repair of dialysis machines, incorporating *Equipment Service*, *Live Test* and *Component Storage* areas which should be amalgamated into a single area to form the general laboratory. There is also a *Ready Use / Equipment Out Lobby*, which should be external to the general laboratory, and configured as an open area for direct access by clinical staff.

Equipment Servicing Area

This space should be sufficient to manoeuvre into and park within 8 test stations, dialysis machines undergoing repair/testing. Laboratory grade benching should be a feature of surrounding walls with appropriate quantities of under-bench cupboards and drawers and above-bench single/double shelving as practical.

7 x test stations must each incorporate :-

- Easily accessible under-bench fluid supplies and drains to operate equipment as per ward.
- 6 x 13A power outlets with 30mA residual current device protection.
- Computer network comm. port.
- “Angle-poise” inspection lamp.

Variable airflow ventilation is <u>essential</u> with high level extraction/cooling to deal with up to 14KW heat output from disinfecting equipment and for fume extraction of chemical disinfectants.

Under-bench bay required with 6 x pure water supply, 6 x drain, 6 x 13A power outlet to accommodate auto disinfection of single-patient portable reverse osmosis (R.O.) units. Also one “raw” water supply for R.O. efficiency testing.

A hand washbasin with wrist operated taps plus one deep plastic laboratory sink.

Live Test Area

Benched area of approx. 6 M2 designed as a *“Live Test”* area with requirements as per HSE Health and Safety Executive “Safety in Electrical Testing at Work – General Guidance” including for instance :-

- Live test area to be earth free with minimum exposure of conductive parts.
- All electrical supplies within area via isolation transformer.
- Floor area fitted with insulated rubber mat.
- Stop switches mounted : one in immediate test area and one inside lab.entrance
- Illuminated warning sign mounted outside lab entrance

This area should accommodate 1 x test station incorporating :-

- Adjacent fluid supplies and drains to operate equipment as per ward.
- 6 x 13A power outlets supplied from the isolating transformer.
- “Angle-poise” inspection lamp supplied from the isolating transformer.

Component Store

Storage area of 16 M2 configured approx. 8M x 2M for component storage drawer system

Ready Use equipment / Out Lobby

Ready use / run-up area of 9 M2 accessible to clinical staff for storage / disinfection / preparation of dialysis machines.

- This should be configured as an open area, for direct access by clinical staff, 1.5 M x 6 M , partitioned from the Laboratory and situated on its outside perimeter.
- This area will have 5 bays, each with 2 x 13A power outlets and fluid supplies and drains to operate equipment as per ward .

Treatment Area: dialysis, Day Case Bay (x 4) and Inpatient Centre (x 4)

The dialysis area may consist of dialysis stations arranged in modules taking into consideration the needs of staff communication with groups as well as plumbing and electrical needs. In choosing chairs, a consideration is that chairs could be modified so that they may be used as cycle machines for exercise for patients whilst on dialysis. Sufficient space must be allowed for the chair to be fully reclined and for nurses to carry out all procedures. Treatment stations need to be arranged so that patients can be attached to the machine by either arm or by cannulae in their neck or groin (dependent upon access). One emergency call button (with audible and visual alarm) should be provided.

Storage space is required at each station for frequently used medical items and for patients to carry out activities e.g. watching television whilst undergoing dialysis. Easily reached storage shelves are required for staff use. Dialysis chairs with integrated tables are required for patients. The need for a computer outlet, telephone point and network connection point at each station is a consideration as well as computer data points for staff. One CHWB is required between two stations, with:

Alcohol hand rub

Wall mounted soap and scrub dispenser, aprons and gloves

A towel dispenser

Clinical and non clinical waste bin

A sharps container

Minor Procedures & Treatment Room (incl prep)

Activities undertaken in this area will include renal biopsies, line insertion, stent removal etc and consequently it should be spec’d as a minor procedures room capable of supporting minor surgical interventions in a sterile environment.

Higher Acuity / Level 2 Bed: single room @ 20m^2
A space allowance of 20m2 is required. A medical supply unit for multi-parameter monitoring, medical gases (oxygen and air), medical vacuum, and electrical outlets must be provided; this may take the form of overhead articulated arm(s) or gantry – wall mounted supply is discouraged. Natural daylight is desirable and, if present, controllable blackout blinds will be required. Artificial light, apart from examination light, should be indirect with wall dimmer controls. The colour of the walls must not distort the colour rendering of the examination lights so that changes in the patient's colour can be readily identified.

There must be enough space around the bed for use of resuscitation and haemodialysis equipment. Each bed area must also be large enough to accommodate mobile imaging equipment and have appropriate radiological protection.

Natural daylight and preferably a view must be provided.

Bulk supplies store (12m^2)
This bulk supplies area is a holding store for medical and surgical supplies and intravenous fluids from which to stock the clean utility and other areas. The amount of storage is determined by local supplies policy and 'just in time' system Clean disposable bedpans and urinals can be stored in this area.

Clinical Equipment Store (16m^2)
Floor space is needed for a variety of equipment including drip stands, monitoring equipment, etc, but haemodialysis equipment will be kept in the bedroom or in another storage area. Shelf space is needed for smaller items of equipment such as infusion pumps, monitoring equipment and suction apparatus. Power is required for the charging of this equipment. This store should be located within easy access of bed areas and near to the equipment service room.

RISK MANAGEMENT

The overall design and layout of the ward should aim to reduce the risk of harm to patients and staff. It should also take into consideration the latest technical and planning guidance/consideration related to the full range of issues that may constitute a "risk" including patient safety, infection control, staff safety, etc.

DISABILITY ACCESS

The accommodation must conform to the requirements of the Disability Discrimination Act 2005. This includes wheelchair access into rooms, provision for those who have hearing or visual impairments and for obese patients, e.g. rooms will require turning circles for wheelchairs, induction loops, tactile surfaces for the visually impaired, and fittings suitable for heavy patients e.g. floor mounted sanitary ware.

NEW SOUTH GLASGOW HOSPITAL

Clinical Output Specification

AREA	**GENERIC ADULT WARDS**

1. INTRODUCTION

The inpatient wards of the South Glasgow Hospital will, as far as possible, comprise a generic design of wards in order that they may flex optimally over time between specialties and patient groups in order to respond to clinical and demographic changes without the need for major re-configuration. At the moment the plan is that each ward will have 28 beds but, at some stage in the future, there may be a requirement to change the number of beds between the wards therefore the wards should be configured in such a way that will allow flexibility. In other words the clinical spaces and rooms of each of the 4 wards should ideally join on to each other to allow individual ward boundaries to change in the future if required.

In total, the adult hospital will include 9 floors of generic wards, each ward with 28 beds in single rooms with en-suite facilities.

It should be noted that different fittings will be required in some generic wards and that some rooms may be re-classified within the standard layout in recognition of individual specialty needs. As far as possible however, generic ward designs will be unaltered, with specialty specific areas accommodated within the "cluster accommodation" that is common to each ward floor.

Generic ward accommodation is presented within the Schedule of Accommodation (SofA) under the section entitled "Generic wards", whilst cluster accommodation is listed in the SofA under the heading "Support cluster". Whilst some specific differences in generic ward areas are identified in this document it is important to read it in conjunction with all of those COS's that refer to clinical services/specialties that will be delivered within ward accommodation.

The Assessment beds in the Emergency Complex (EC) will share many of the principles of the generic ward accommodation; however, these are described separately in the COS for the EC.

1.1 Services Provided

Generic ward accommodation is required to provide patient-centred Level 0 to Level1 care for adults in standardised (28 bed) wards that may be flexed between medical and surgical patient care across a wide range of clinical sub-specialties in response to changing patient numbers and need. The service provides for adult medical and surgical emergency (unscheduled) and planned (scheduled) admissions.

Specialties appropriate for generic accommodation include:

- Cardiology
- Care of the Elderly
- General Medicine
- General Surgery
- Haemato-Oncology
- ENT
- Stroke
- Trauma and Orthopaedics
- Urology
- Vascular

This accommodation will be used for adult patients (those aged 16 and above), with patients below this age being admitted to the Children's Hospital.

All accommodation within the adult facility must recognise the needs of an ageing population in reflection of well documented demographic trends and should be designed to be as safe as possible at all levels.

1.2 Services Excluded

A number of specialties are not suitable for generic ward accommodation due to their required footprint/layout being different to the generic layout. These specialties are:

- Renal (including level 2 care)
- Haemato - oncology
- Dermatology
- Critical Care (level 2, level 3 and coronary care)

The above specialties have patients with a mixture of needs and issues that differ from those using a generic ward. For example they may require level 2 and/or level 3 care, or a different configuration of support accommodation, e.g. To support the delivery of specific treatment/care.

It is noted however that the plan-form for in-patient accommodation within these areas can and should be the same as for the generic ward component wherever possible to further support future flexibility.

In addition it is noted that:

- Children's services are excluded.

- Maternity, gynaecology, neurosciences (including maxillo-facial) and some elderly care and rehabilitation beds will be provided within retained buildings that are to be linked to the facility through new covered connections. These connections should facilitate direct access to the maternity and neurosciences buildings for both staff and patients.

2 Location & Links

2.1 *Clinical Facility Requirements*

The main clinical components of the generic ward model are:

- 28 single rooms per ward - all with en-suite accommodation
- All single rooms at 16.5m^2 (including associated family/clinical support space)
- All rooms with en-suite chamfered showers, WC's and WHB's as per HBN 00-02 at 4.5m2.
- All rooms to be capable of using the global footprint available to support patient care as required both within the bedded and en-suite areas, i.e. Rooms should be designed in a manner that allows the en-suite and bedded component to at different times "borrow" space from the other.
- All rooms to optimise patient/staff observation and the volume of natural light entering the entire ward whilst minimising travel distances for staff and ensuring the maintenance of privacy and dignity.
- Where blinds require to be fitted these should be encased.
- 1 room per ward will be used for isolation purposes and will have an associated gowning lobby.
- All rooms will feature a range of bedhead services that should include medical gases (oxygen, vacuum & medical air), nurse call and emergency call – ideally linked to portable receivers carried by nurses, power & data outlets, patient entertainment system (entertainment system specification to be determined) and lighting.
- Ceiling mounted tracking hoists should be installed in 6 rooms within each generic ward as standard. The rooms with tracking hoists should be located as close to key observation areas as possible and should be considered to be those rooms that will accommodate the patients who require the most care intervention and the closest observation. All tracking should be kept as straight as possible to minimise travel distances and maintenance requirements.
- Some wards will require a greater number of tracking hoists due to the specific requirements of the patient groups that they care for. These wards are Trauma and Orthopaedic, Stroke and Vascular and Care of the Elderly.
- IT is seen as fundamental to the efficient functioning of the new facility and should be considered at every stage of the design process. In particular the use of IT to reduce workload, repetition and errors is key. A separate document outlines IT requirements and specifications.
- Specifically, the IT network should include an infrastructure for telemetry facilities for each ward, with the receiver at the main staff base and the capacity for telemetry to be used on any patient within the ward. Ideally telemetry information should also be capable of being relayed to staff throughout the ward in recognition of the desire to move away from a centralised nursing station.
- Telemetry facilities should also enhance the case-specific monitoring of individual patients/groups who are confused or may try to leave the bed or room unassisted.
- The move away from a single nursing station should also be supported by the provision of informal desk space, possibly at standing height, throughout the clinical area, e.g. "Touch down stations". These areas may, at different times,

be used by all members of the multi-disciplinary team and should support the requirements of immediate documentation review/completion (ideally electronically) as well as direct two-way observation.

- Many staff within the new hospital will be moving from Nightingale style wards and technology is also seen as crucial to supporting their clinical observation of patients within single rooms.
- Secure medicines lockers should be provided at each bedside for the storage of patients' own drugs and to facilitate patient self-administration of medications as appropriate.
- A secure pneumatic tube station should be provided at an appropriate location within each ward, for example the clean utility. This should be linked to the wider vacuum tube network that will link all areas within the new hospital.
- An interview room is required, as is the essential office accommodation to support direct clinical activity and management of the ward. This should include flexible (private) desk space for the multi-disciplinary team and a dedicated central administrative/reception area which can be thought of as the administrative "hub" of the ward.
- The majority of offices, e.g. for consultant staff will not be within the new facility but will instead be located within other parts of the retained estate.
- Public access to the wards should be controllable at all times with e.g. proximity card access/video-entry phone although it should also be recognised that out of hours access may require direct communication with staff in the clinical area as the administrative hub is unlikely to be manned out with "office hours". The control entry phone should therefore be accessible from several points in the ward near nurse bases.
- Clean and dirty FM routes and patient / staff routes should be clearly identified and should be kept separate as far as possible.

2.2 *Internal Relationships*

2.2.1 Cluster Model

A cluster model should be adopted for the configuration of the wards, i.e. the wards on each floor should be clustered around a centrally positioned support core containing FM, administration and other support services.

These support clusters / cores can in turn be thought to be composed of two components; a component that is generic to all ward clusters and a variable component which reflects the requirements of the wards it supports.

Essential components within every support core will include:

- A regeneration kitchen
- A central wash-up area
- A disposal hold (will also hold soiled linen)
- Cleaner's room
- Staff locker/changing rooms
- Medicines management space
- Flexible administrative (workstation) space

In addition, areas that may feature within some support cores – dependent upon the ward cluster that they are accommodated within – include:

- Seminar/education/teaching space (*seminar space has been allocated within the ward tower stack*)
- Bulk fluids storage (particularly on surgical floors)
- Therapies space (Including ADL assessment space)

For more details please see Section 7 'Accommodation Requirements'.

The maximum number of wards that should be served from a support core is four, but could be less.

From the passenger lift area; there should be a public entrance to each ward that is separate from the clinical access entry point. This relationship gives separation of Facilities Management (FM), visitor and patient routes. The FM support core should have separate clean and dirty service lifts connecting to FM routes and to delivery and collection bays. This model can operate with a varying number of wards in each cluster and the core can be extended to include other rooms that can be shared between wards.

This approach has a number of benefits:

- It restricts the crossing of patient, visitor, staff and FM flows and the associated risks
- It improves security by restricting the public to parts of the building and routes that are less sensitive.
- It improves privacy and dignity for patients who are being transferred to another department, e.g. for surgery or a diagnostic procedure.
- It helps with fire evacuation planning by providing alternative horizontal evacuation routes from the ward
- It restricts the movement of goods and services to a staff controlled area which can be well protected against physical damage

2.2.2 Support Core Accommodation Relationships

The route from each ward served by the support core to the disposal hold / recycling, regeneration and wash-up kitchen should be short and direct. The workstations, seminar, therapy and staff changing areas should, as far as possible be apart from the FM rooms.

2.2.3 Ward Relationships

The Board recognises that the move from Nightingale wards to 100% single rooms with en-suites will represent a significant change in practice for both staff and patients, with a key element of the successful design being the ability to optimise the two-way visibility of staff and patients whilst also providing opportunities for socialisation.

Nursing establishments/models in all wards will be based upon the patient dependency, ward occupancy and skill mix. It will be crucial that ward design and layout compliments visibility from a patient perspective and staff perspective, consequently designs should be flexible enough to support varied staffing levels and

the effects on the number of rooms being supervised by any given individual/team of nurses, i.e. Where patients dependency increases and a requirement for closer observation a nursing team will supervise fewer patients/rooms than in those areas where the opposite is true.

Whilst, as noted previously, the use of technological ways of achieving this should be explored, a number of design priorities should also be observed, as should the general principles of "Releasing Time To Care (RTTC) The Productive Ward" this programme has 11 modules i.e. 8 clinical and 3 environmental modules. (NHS Innovations 2008)

2.2.3.1 Staff Bases

As noted previously, multiple staff bases are likely to be required, with a key element of the design the requirement to observe as many patients as possible from each base. It is anticipated that the optimal configuration may feature a main "clinical hub" (nurses station) supported by multiple supplementary "touch down" stations. These will also allow staff to update their documentation close to the patients rooms (will also undertake some documentation update in patients own rooms).

2.2.3.2 En-suites

The position of the en-suite should not compromise the observation of bedrooms. Consideration, therefore, should be given to how good observation levels can be achieved from corridors and staff bases. In this context, the positioning of en-suites relative to beds is extremely important.

The preference of the group reviewing ward design, based upon a wide number of visits to different facilities, is for predominately "out-board" ensuites with possibly some "inter-locking" en-suites as it is believed that this delivers the optimal combination of two-way observation, light ingress, travel distances and economy of the footprint. The most important issue is to get the right balance between clear observation and access to natural light.

2.2.3.3 Single Rooms

All clinical care will be delivered in single rooms as far as possible including all minor procedures that would traditionally have been performed in a treatment room. Treatment rooms are consequently not an identified component of the generic ward. Consequently room design should support these interventions including providing enough work surface and useable floor space.
(NB The exception to the above is ENT which does have a treatment room – see ENT COS)

The location of the clean utility and dirty utility spaces will also be essential to support efficiency within this model.

2.2.3.4 Entry, Reception & Waiting

Separate entry points are required to each ward; one for visitors and another for patients and staff. The route from the lifts and stairs should be short and clearly signed. Toilets for visitors should be positioned near the lifts rather than on the ward. Just inside the entrance to each ward an open fronted office for a ward clerk with window to the corridor and space for a few chairs is required. The ward office should be adjacent to this as together these elements will form the administrative centre of the ward.

2.2.3.5 Workstation / Admin Space

The care model will seek to keep more members of the staff on the wards and thus a 2 position workstation area is required. It will be beneficial for this to be adjacent to the ward office.

2.2.3.6 Moving Beds in and out of Bedrooms

It is essential that beds can be manoeuvred in and out of bedrooms, along corridors and out of the ward to bed lifts to, for example, operating theatres and critical care. The main ward corridor doors should be automated to allow the passage of beds through.

The maximum dimensions of beds (including attachments where necessary, e.g. Drip stands, pumps, monitoring equipment, orthopaedic traction frames etc) should be taken into consideration in this regard. Similarly, bed lifts must be able to take a bed and attachments along with up to 4 attendant personnel.

2.2.3.7 Utility Rooms

The position of the dirty utility room(s) must ensure that distances from bedrooms are not excessive. Similarly, the clean utility room should be centrally positioned in relation to bedrooms. Depending upon the ward design employed and the travel distances to/from the dirty utility area a second dirty utility room may be required.

2.2.3.8 Socialisation Space

Although it is anticipated that all patients accessing wards within the facility will be acutely unwell and will only remain there during the very acute phase of their illness/treatment, the need to support patient socialisation has been identified as a design consideration. It is noted that socialisation needs should be considered within the overall design of the ward but that this should, as far as possible be addressed through informal space within the clinical area – possibly within circulation areas – rather than the traditional day room/dining area which is not regarded as appropriate for this type of acute hospital environment. The ability to observe/monitor patients accessing this space is also a key consideration.

2.2.3.9 Equipment Store – There should be access to electrical sockets within the equipment store.

2.3 *Access & Key Departmental Relationships*

Close to	Reason	Category*
Acute Assessment Unit	Expedite transfer route	Essential
Theatres (surgical wards only)	Access to theatre	Essential
Critical Care	Patient transfer	Important
Imaging	Patient journey	Important
Renal services	Patient journey	Important
Endoscopy	Patient journey	Important
Emergency Department	Expedite transfer route	Important
Main Entrance (incl Admission & Discharge Lounge)	Patient journey	Important
Imaging	Patient journey	Desirable
Nuclear Medicine	Patient journey	Desirable
Medical Photography	Patient journey	Desirable

*Category: Essential/Important/Desirable (Essential in this case meaning rapid access required, could be via lift)

2.3.1.1 Route from Emergency Complex (ED & AAU)

A staff and patient only route from ED & EC to the patient bed lift core, which connects with the ward tower, is required.

2.3.1.2 Route from Main Entrance

Patients and escorts will book in at the admissions desk in the main entrance and from there proceed to the lift core / stairs to the level their ward is on.

2.3.1.3 Route to Langlands Building

There is a need to have designated route for vehicles to transfer patients to Langlands from the wards (high level of transfer activity).

3 Activity Indicators

3.1 *Service Trends & Strategy*

Increasingly, acute care hospitals will have patients at a high level of dependency/acuity, both at the emergency and elective level of care. Surgical patients will either be high risk with associated co-morbidities undergoing relatively simple surgery or will be undergoing complex major interventions (these patients may, of course, also be high risk with associated co-morbidities). Medical patients are also likely to have a significant number of co-morbidities and complex needs. All patient groups will have an increasingly elderly component

The current obesity problem is likely to continue in the future, leading to issues concerning manual handling, equipment and bed sizes for patients. In this context, this project incorporates six overhead hoists per ward and recognises the requirement for all en-suites to be the equivalent of “double assist”.

As demographic and other issues impact on the workforce, particularly nursing, the trend is likely to be that expertise is concentrated within areas of high acuity, such as critical care. This will create a staffing challenge at ward level in terms of quality of care risk management. New ways of working will continue to develop, with many members of the care team sharing the full range of required duties. Hoists should be capable of coping with bariatric patients.

Training requirements for clinicians, nurses/midwives and AHPs are under review nationally with access to training facilities at ward level regarded as essential. To this end schedules of accommodation identify the provision of seminar rooms that will be shared between each cluster of 4 wards, although it is further recognised that additional facilities for training will also be required, although these will be delivered through a separate facility on, or nearby, the Southern General site.

Infection control and its requirements are only likely to increase as the current focus on controlling Heathcare Associated Infections (HAI) is unlikely to shift in the future - underlining the importance of pursuing all developments in line with HAI - SCRIBE.

4 Hours of Service & Work Patterns

4.1 *Operating Hours*

All inpatient wards provide a 24-hour service 365 days a year. Administrative areas are unlikely to be staffed out with office hours; particularly when the facility is first opened and the implications of this should also be considered within the design. Specifically this should allow for these areas to be locked when unstaffed with a separate provision for out of hours visitors to make contact with ward staff before being allowed access to clinical areas.

5 Care Model, Pathway & Patient Flows

5.1 *Care Model*

5.1.1 General

Patients may be admitted to generic wards from a number of areas including:

- The Emergency Department (part of the Emergency Complex)
- Acute Assessment areas (within the Emergency Complex, including GP referrals)
- Booked / elective admission lists (following referral to a specialty)
- Other specialties / hospitals by transfer (The majority of unscheduled transfers will be seen in the EC initially)
- The Operating Department
- Critical care (ITU/CCU/Surgical and Medical HDU)
- Radiology (interventional and other procedures)

These admissions may be either scheduled or unscheduled.

Separating scheduled care from unscheduled care is an important element in planning for the optimal utilisation of all resources and will be key to the overall model employed in the new hospital.

Scheduled patients will all (where it is deemed to be beneficial) visit a pre-admission assessment clinic as part of their care pathway, with a successful outcome from this clinic essential before they are admitted. As a component of the successful conclusion to pre-admission assessment, patients will be given a date, time, location and method of admission that will see them:

- Go directly to the admissions office in order to be admitted to a ward or other bed/trolley/chair e.g. Medical Day Bed Unit
- Go directly to the admissions office in order to be admitted to a ward bed on the morning of surgery or on the day prior to surgery
- Go directly to an “Admission on day of surgery area” within the operating theatre dept, before transferring to a booked bed on a generic ward for their recovery

Unscheduled care is unplanned at the point at which the patient presents in hospital, with the Emergency Complex providing the main point of access for most unscheduled care in order to ensure effective and prompt patient management. This facility will enable clinicians to identify both the presenting problem and any related social or medical issues/co-morbidities at the point of presentation or as soon as

possible thereafter and thus initiate appropriate and timely treatment and management of the patient. The EC will provide a multi-disciplinary approach to initial assessment/treatment further supporting the early commencement of multi-disciplinary care pathways.

Following assessment, which will include the review of a range of test results, those patients deemed to require inpatient care will be admitted to a ward of the appropriate speciality/acuity, whilst others will be discharged from this facility or transferred to more appropriate care as appropriate. It is anticipated that patients may be cared for within the EC for up to 24 hours in total from time of admission. (Please refer to the AAU COS for specific details)

This form of unscheduled care management results in the patient being put on a care pathway at an early point in their care; thus their recovery time and consequently length of stay is reduced.

Care provided on the ward includes assessment, treatment and acute rehabilitation sufficient to enable the patient to return home, be transferred to intermediate care or rehabilitation in the community within 8 hours of being declared medically fit for discharge. The discharge process is aided by the use of a central discharge lounge to accommodate patients waiting for transport. This also ensures that beds are released for booked admissions in a timely fashion.

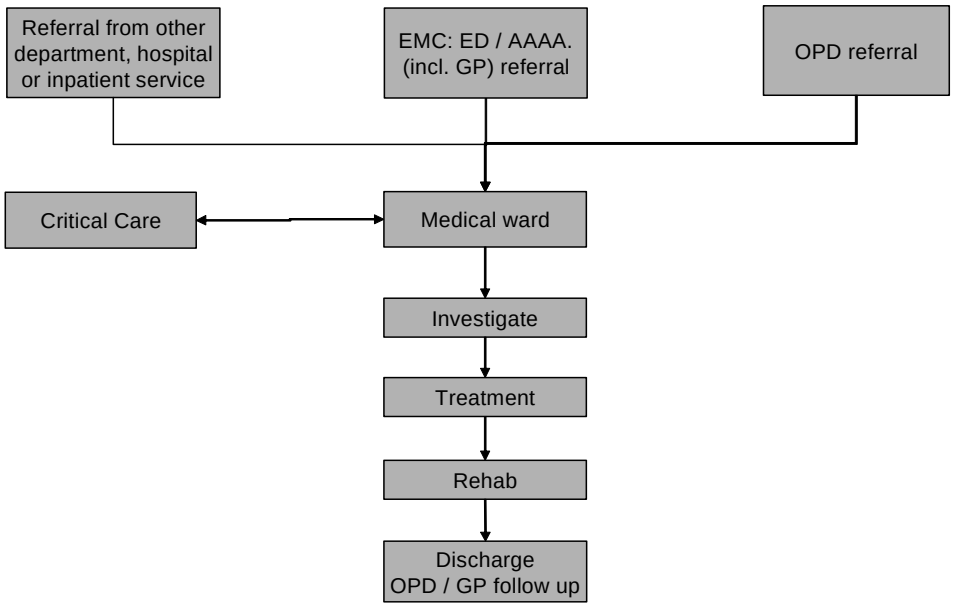
A multidisciplinary team of specialist healthcare professionals provides holistic care and this includes medical staff, nurses, allied health professionals (AHPs) pharmacists, healthcare assistants and clerical staff. Therapy staff will see patients on the ward at their bed space or in the interview room. Alternatively, they may use centrally located therapy facilities in the ward cluster support space.

The clinical service delivery model includes medicines management that allows professional pharmaceutical support to be provided directly to patients and members of the multidisciplinary team thereby improving this component of the overall care package from admission through to timely discharge with appropriate drugs.

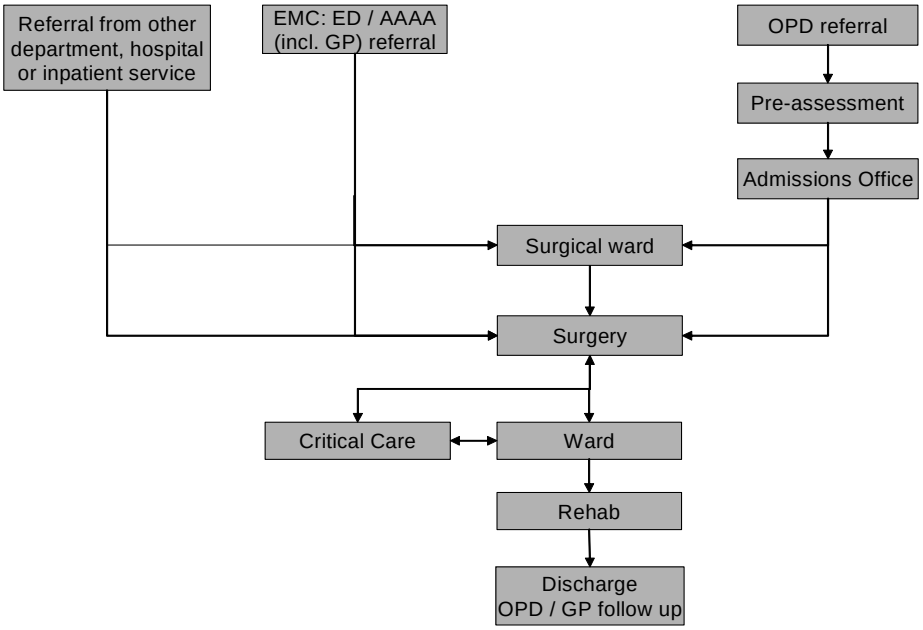
This generic service delivery model represents a standardised approach to the provision of inpatient facilities and care that is as flexible as possible. The overall aim is to provide patient-centred services whilst future proofing the structure and functionality of the hospital.

5.2 *High-level Patient / Process Flow & Service Delivery*

Medical / Elderly Generic Wards



Surgical Generic Wards



5.3 *Elective Admissions & Discharge Lounge*

The Discharge lounge will be situated on the ground floor accessible to both the ward tower and to the Emergency Complex and will support patients identified as appropriate to wait under nursing supervision for their transport to arrive.
The elective admissions reception will be in the main entrance Hall. Patients arriving for elective procedures will be booked in at the admissions desk and directed to their ward/admission area as appropriate.

As previously noted admission may be to a ward, operating theatre 'Admission on day of Surgery' area (AODOS area) or other facility.

The details of the discharge lounge are in the Discharge Lounge Clinical Output Specification.

6 Design Guidance

Please also see separate guidance document. As noted elsewhere, the generic ward component of the facility will comprise of 100% single rooms. This decision is based upon the best information available at this time and is designed to optimise current and future flexibility whilst addressing HAI issues, mixed-sex ward issues and core concerns around privacy, dignity and infection control.

6.1 *Design Requirements & Guidance*

Please also see separate guidance documentation. Some of the key issues that should be considered are that the design :

- Supports innovative models of healthcare delivery
- Creates an optimal healing environment and promotes the well being of those who are ill and their caregivers
- Is Customer/ patient friendly
- Enables efficient patient flows
- Enables efficient- staff flows
- Enables Clear Clinical pathways
- Allows for state of the art technology

The technological nature of hospital services may be an unpleasant experience for patients and their relatives. It is important, therefore, that when designing these facilities the patient experience is taken into account together with that of their relatives and carers. The emphasis should be on providing a comfortable, pleasant but safe environment for patients and staff, with particular emphasis on the wider therapeutic elements of the design and finishes.

It is also essential to consider the needs of staff and the impact that the working environment has on job satisfaction, recruitment and retention.

Addressing gender, cultural and religious diversity is also a consideration as are the needs of relatives, carers and visitors whose opinions must be sought throughout the design process and taken into consideration.

Additionally, consideration should be given to alleviating fear and anxiety, maximizing security and safety, reducing boredom and creating a healing environment with the need for artwork, designed furniture, fittings, cabinetry, etc also a consideration.

Imaginative use of floor and wall finishes, colour and lighting will help to produce a warm, friendly environment. However, all must conform to infection control and other guidance, be seamless, easy to clean resistant to damage.

6.2 *Environmental and Services Requirements*

These should correspond to the standards described in the relevant SHPNs, HTMs and other technical guidance and the technical output specification for this project. In addition, consideration must be given to protecting the privacy and dignity of patients. Sound attenuation measures to ensure speech privacy in consult / exam, treatment, scanning and other rooms where patients and clinicians have private discussions should be provided.

The design also needs to take account of the need to create a pleasant environment for the patients and staff by means of good design, locally controllable lighting and access to natural light and views.

Coved and welded seamless washable plastic flooring is preferred. This must be able to withstand 10,000ppm available chlorine. Walls must be washable, with plasticised panelling preferable and consideration should be given to the use of flooring that minimises the traumatic effects of falls. Walls should have as few protrusions as possible and there should be no carpets in any clinical area.

7 Accommodation Requirements

7.1 *Rooms & Spaces Required*

All of the required rooms/spaces are identified within the SofA with room details/specifications to be in line with the identified guidance.

7.2 *Variations*

There will be small variations between wards and shared ward support facilities that should be accommodated in the layout and design without significant alterations being made. For example, generic wards used for orthopaedics will have more overhead hoists than those used for cardiology and the requirements for the AHP/therapy area will vary depending on the adjacent wards. This is described in more detail below.

Shared Ward Support Cluster

The Shared wards support cluster (ie cores) have two components; a component that is generic to all ward clusters and a variable component which reflects the requirements of the wards it supports. For example the requirements for the AHP/therapy area will vary depending on the adjacent wards. Also, bulk fluid storage will be provided near surgical wards only.

Specifically, ward support facilities will be varied as follows (based on the PSC Exemplar ward tower of 8 floors x 4 wards and 1 floor of 2 wards):

Shared Ward Support Core
For Floor with 4 wards

	Qty	Unit Area m²	Total Area m²
Shared Ward Support Facilities			
Regen Kitchen	1	30.0	30.0

Allowance for Wash Up	1	12.0	12.0
Disposal Hold & Recycling Point	1	24.0	24.0
Workstations x 6	1	24.0	24.0
Medicines Management	1	12.0	12.0
Staff WC/wash	3	2.0	6.0
Staff locker room - F	1	24.0	24.0
Staff locker room - M	1	8.0	8.0
Staff shower	2	4.0	8.0
Accessible shower / WC	1	4.5	4.5
Cleaners Room	1	7.0	7.0
WC - Wheelchair Visitor	2	4.5	9.0
WC/WHB - Visitor	4	2.0	8.0
Multi Functional Cluster	1	80.0	80.0
Sub Total			**256.5**
Net subtotal for Shared Ward Support Facilities			**256.5**
Planning Allowance	5%	12.8	
Engineering Allowance	3%	8.1	
Circulation Allowance	25%	67.3	
Gross subtotal for Shared Ward Support Facilities		**344.7**	

Multi Functional Cluster A (1 in number)			
Seminar / Education Room	1	40.0	40.0
Therapy Room (ADL beverage assessment)	1	*12.0*	12.0
Bulk Fluids & Clean Dressings etc Store	1	*28.0*	28.0
			80.0
Multi Functional Cluster B (3 in number) (co-located with ortho, Elderly and Medical wards)			
Therapy Area and store	1	*80.0*	80.0
			80.0
Multi Functional Cluster C (2 in number)			
Seminar / Education Room	1	80.0	80.0
			80.0
Multi Functional Cluster D (2 in number)			
Seminar / Education Room	1	40.0	40.0
Bulk Fluids & Clean Dressings etc Store	1	*40.0*	40.0
			80.0

For Floor with 2 wards (1 in number)

	Qty	Unit Area m²	Total Area m²
Shared Ward Support Facilities			

Regen Kitchen	1	24.0	24.0
Allowance for Wash Up	1	10.0	10.0
Supplies Storage & Distribution Area			0.0
Disposal Hold & Recycling Point	1	16.0	16.0
Seminar / Education Room	1	40.0	40.0
Workstations x 6	1	24.0	24.0
Therapy / AHP / Multi Purpose Assess / Treat	1	40.0	40.0
Medicines Management	1	12.0	12.0
Staff WC/wash	3	2.0	6.0
Staff locker room - F	1	16.0	16.0
Staff locker room - M	1	6.0	6.0
Staff shower	2	4.0	8.0
Accessible shower / WC	1	4.5	4.5
Cleaners Room	1	7.0	7.0
WC - Wheelchair Visitor	1	4.5	4.5
WC/WHB - Visitor	2	2.0	4.0
Sub Total			**222.0**
Net subtotal for Shared Ward Support Facilities			**222.0**
Planning	5%		11.1
Sub-Total			233.1
Engineering	3%		7.0
Circulation	25%		58.3
Total			**298.4**

In other words each of the 4 ward floors will have the following (ie the component that is generic to all ward clusters): a regeneration kitchen, a central wash-up area, a disposal hold, Cleaner's room, Staff locker/changing rooms, toilet facilities, a Medicines management room and flexible administrative (workstation) space.

In addition each of the '4 - ward floors' will have a variable component consisting of a 80m2 multi-functional cluster. For ease of description these multi-functional clusters have been labelled A,B,C and D.

Cluster A

On one floor the 80m2 multi-functional cluster is composed of seminar space, a therapy area (beverage assessment 12m2) and bulk fluid storage.

Cluster B

On three floors, (next to orthopaedic wards, Care of Elderly and Medical Wards) this 80m2 multi-functional cluster will be composed of AHP Therapy space. (See further description below in Section 7.2)

Cluster C

On two floors the 80m2 will be composed of seminar room space – the design of the 80m2 on each floor should be flexible allowing this space to be to used as two 40m2 seminar rooms or, when required, to be opened up into a single 80m2 seminar room. (All seminar rooms throughout the building should be capable of supporting PC's, projector and telemedicine).

Cluster D

On Two floors the 80m2 multi-functional cluster will be composed of a 40m2 seminar space and a 40m2 bulk fluid store room.

The composition of the ward support cluster on the final floor, which has two wards, is given in the schedule above.

Description of the Therapy Areas

7.2.1 Orthopaedic Rehabilitation

Requires 80m^2 (net) therapy area to serve the whole of the orthopaedic floor (including orthopaedic rehabilitation ward):

Therapy area with 3 plinths that can be screened, steps/stairs, ceiling tracking, standing frame, adjustable table, 1-2 parallel bars, workstation and gait assessment area.

Therapy store for equipment e.g. hyrolators, gym balls and samples of helping aids.

7.2.2 Elderly Rehabilitation Inpatient Care Model

Requires 80m^2 (net) therapy area to serve whole of elderly care floor:

Therapy area with 3 plinths that can be screened, steps/stairs, ceiling tracking, standing frame, adjustable table, 1-2 parallel bars, workstation and gait assessment area.

Therapy store for equipment e.g. hyrolators, gym balls and samples of helping aids

7.2.3 Other Wards

A need was also identified to include a further 80m^2 (net) therapy area to serve medical wards. Therapy area with 3 plinths that can be screened, steps/stairs, ceiling tracking, standing frame, adjustable table, 1-2 parallel bars, workstation and gait assessment area. Therapy store for equipment e.g. hyrolators, gym balls and samples of helping aids

The inclusion of a beverage assessment area is required on one of the remaining floors of the ward tower i.e. one that has no other rehabilitation provision.

Note - one of the therapy areas in the ward stack should have an ADL kitchen – with gas and electric cookers in a quasi domestic setting. This will most often be used by patients from orthopaedic and medical wards and should be located in whichever of the therapy clusters on those floors gives best access to the largest number of patients.

8.3.4 ADL facilities for the New South Hospital

Activities of Daily Living assessments are an essential part of rehabilitation and discharge planning.

There are two ADL areas, one co-located with the stroke ward and one located within the Acute Assessment Area. Both areas will also be used by patients from medicine for the elderly wards, medical wards, surgical wards and orthopaedic wards and should therefore be located so that they can be accessed without disrupting the main department and so that inpatients' privacy is maintained whilst they are being transferred.

Both of these are briefed for bathrooms and WCs. Showers are not required as each bedroom will have a shower. Baths and WCs must be approachable from both sides to replicate patient's own homes and should be domestic style and accessible for hoists. An ADL kitchen is also required in each- described in the section above.

7.3 *Risk Management*

The overall design and layout of the ward should aim to reduce the risk of harm to patients and staff. Key elements of this risk reduction strategy should include, but not be restricted to:

- Ligature points being avoided wherever possible through the selection of fittings and materials that reduce risk
- Door handles must not have thumbscrews
- The clinician should be positioned closest to the exit door of the room when consulting with or treating a patient
- Wall mounted 'up and down' lighters should be used rather than angle-poise lamps for bed positions
- Sharp edges should be avoided
- Wall mounted items of equipment such as fire extinguishers should be recessed to prevent damage
- Wall / door protectors should be used where there is risk of damage from e.g. bed / trolley movement
- It should be possible for staff to lock-off the en-suite

7.4 *Disability Access*

The accommodation must conform to the requirements of the Disability Discrimination Act 2005. This includes wheelchair access into rooms, provision for those who have hearing or visual impairments and for obese patients, e.g. rooms will require turning circles for wheelchairs, induction loops, tactile surfaces for the visually impaired, and fittings suitable for heavy patients e.g. floor mounted sanitary ware

NEW CHILDREN'S HOSPITAL

Clinical Output Specification

AREA	INPATIENT WARDS

1. INTRODUCTION

The inpatient wards of the New Children's Hospital will, as far as possible, comprise a generic design of wards in order that they may flex optimally between specialties and patient groups in order to respond to clinical and demographic changes without the need for major re-configuration. The plan is that each ward will be grouped in 8 bed clusters. There may also be a requirement to change the number of beds between the ward areas therefore the wards should be configured in such a way that will allow flexibility.

Support accommodation for the wards should be co-located in a central area to allow maximum efficiencies

Services not included:

Renal day care

Haemato - oncology

PICU

Psychiatric Inpatients

The above specialties have patients with a mixture of needs and issues that differ from those using a generic ward.

The Acute Receiving Ward and Cardiology wards whilst having different configured bed numbers will be expected to have a similar design layout to the inpatient bed wards. It is noted however that the plan for in-patient accommodation within these areas can and should be the same as for the generic ward component wherever possible to further support future flexibility.

2. LOCATION AND LINKS

Cluster model should be adopted for the configuration of the wards, i.e. the wards should be clustered around a centrally positioned support core containing FM, administration and other support services.

From the passenger lift area; there should be a clear public entrance to each ward that is separate from the clinical access entry point. This relationship gives separation of Facilities Management (FM), visitor and patient routes. The FM support core should have separate clean and dirty service lifts connecting to FM routes and to delivery and collection bays.

External

Close to	Reason	Category*
Theatres	Access to theatre	2
PICU	Patient transfer	2
Imaging	Patient journey	2
Renal services – *beside renal inpatient ward*	Patient journey	1

*Category: 1 Essential 2 Important 3 Desirable

3. ACTIVITY

see activity tables

4. TRENDS

Due to the movement of the care models towards more ambulatory and day care the inpatients will have higher levels of dependency/acuity, both at the emergency and elective level of care.

Patients with neuro-disability and complex needs leads to issues concerning manual handling, equipment and bed sizes for patients. In this context, this project incorporates six overhead hoists per ward and recognises the requirement for all en-suites to be the equivalent of “double assist”.

Infection control and its requirements are only likely to increase as the current focus on controlling Heathcare Associated Infections (HAI) is unlikely to shift in the future - underlining the importance of pursuing all developments in line with HAI - SCRIBE.

5. HOURS OF SERVICE

24/7

6. WORKLOAD INDICATION

n/a

7. KEY OPERATIONAL PROCESSES/ISSUES

Care Model

Patients may be admitted to generic wards from a number of areas including:

The Emergency Department
GP referral
Booked / elective admission lists (following referral to a specialty)
Other specialties / hospitals by transfer
The Theatre Department
PICU
NICU (Neonatal Intensive Care Unit)
Radiology (interventional and other procedures)
Institute of Neurosciences
Outpatients

These admissions may be either elective or unscheduled.

Care provided on the ward includes assessment, treatment and acute rehabilitation sufficient to enable the patient to return home, be transferred to their local DGH or rehabilitation in the community

Discharge Lounge

To alleviate the pressure on wards whilst awaiting discharge a Discharge Lounge has been allocated in the ward block. Patients and their carers can wait here for discharge drugs, transport etc giving space within the ward at busy times

Within the discharge Lounge there will be a play area and an area for teenagers This will be under nursing supervision with play specialists in attendance.

Socialisation Space

The children's hospital will not have 100% single rooms. This has been agreed following consultation with children, young people and their carers which indicated that there was a strongly expressed preference from both patients and their carers for the retention of a mixture of single and small bed-bays (1-4). This mixture was seen to offer flexibility in addressing a number of factors including the level of illness, the need for isolation, the need for company to aid recovery, and the preference of teenagers, in particular, for either privacy or companionship.

Play areas and teenage space is seen as an important part of the recovery process for children and young people. A model which gives a "clustering" of adolescent patients is still under consideration.

General Points

- Where blinds require to be fitted these should be encased.
- 2 rooms per ward will be used for isolation purposes and will have an associated gowning lobby.
- All rooms to optimise patient/staff observation and the volume of natural light entering the entire ward whilst minimising travel distances for staff and ensuring the maintenance of privacy and dignity.
- Touch-down spaces required for staff at reasonable intervals within ward area
- All rooms will feature power & data outlets
- Ceiling mounted tracking hoists should be installed in 6 rooms within each generic ward as standard. All tracking should be kept as straight as possible to minimise travel distances and maintenance requirements.
- IT is seen as fundamental to the efficient functioning of the new facility and should be considered at every stage of the design process. In particular the use of IT to reduce workload, repetition and errors is key. A separate IT strategy is available that outlines key issues, requirements and specifications in this regard.
- Specifically, the IT network should include an infrastructure for telemetry facilities for each ward, with the receiver at the main staff base and the capacity for telemetry to be used on any patient within the ward. Ideally telemetry information should also be capable of being relayed to staff throughout the ward in recognition of the desire to move away from a centralised nursing station.
- Telemetry facilities should also enhance the case-specific monitoring of infants and other patients who may try to leave the bed or room unassisted.
- The move away from a single nursing station should also be supported by the provision of informal desk space, possibly at standing height, throughout the clinical area, e.g. “Touch down stations”. These areas may, at different times, be used by all members of the multi-disciplinary team and should support the requirements of immediate documentation review/completion (ideally electronically) as well as direct two-way observation.
- Public access to the wards should be controllable at all times with e.g. proximity card access/video-entry phone although it should also be recognised that out of hours access may require direct communication with staff in the clinical area as the administrative hub is unlikely to be manned out with “office hours”. The control entry phone should therefore be accessible from several points in the ward near nurse bases.
- Consideration should be given to staff working requirements – as offices will not be within the hospital build staff will require access to workstations near or in the ward areas but away from the “traffic” of the busy ward environment
- Sleep rooms should be located at the “quiet end” of a ward

Design Requirements

The technological nature of hospital services may be an unpleasant, and indeed threatening experience for children, young people and their families. It is important, therefore, that when designing these facilities the specific needs of children and young people are taken into account together with that of their relatives and carers. The emphasis should be on providing a comfortable, pleasant but safe environment for patients and staff wherever possible, with particular emphasis on the wider therapeutic elements of the design and finishes.

It is also essential to consider the needs of staff and the impact that the working environment has on job satisfaction, recruitment and retention.

Addressing gender, cultural and religious diversity, as they relate to the care of children and young people, is also a consideration as are the needs of relatives, carers and visitors whose opinions must be sought throughout the design process and taken into consideration.

Additionally, consideration should be given to alleviating fear and anxiety, maximizing security and safety, reducing boredom and creating a healing environment with the need for artwork, designed furniture, fittings, cabinetry, etc also a consideration.

Imaginative use of floor and wall finishes, colour and lighting will help to produce a warm, friendly environment. However, all must conform to infection control and other guidance, be seamless, easy to clean resistant to damage.

8. EQUIPMENT

N/A

NSGH
WARD VENTILATION DESIGN STRATEGY

Board Requirement

The design requirements for the NSGH states that the summertime temperature limit is 'not to exceed 26°C'.

This exceeds the guidance provided within the draft SHTM 03-01 on the design of ventilation in healthcare premises, limiting the summertime temperature to 'not exceed 28°C for more than 50 hours per year'.

Natural Ventilation

The SHTM allows for the natural ventilation of areas including general wards. In clause 2.3 it states that 'as the motivating influences of natural ventilation are variable, it is almost impossible to maintain consistent flow rates and ensure that minimum ventilation rates will be achieved at all times. This variability is normally acceptable for general wards'.

Through the use of thermal modeling during the bid stage the use of natural ventilation using openable windows was investigated and results showed that the Board's requirement for temperature control could not be achieved. Furthermore, adding additional background cooled mechanical ventilation, at a quantity to balance the ensuite extract rate, still did not achieve the requirement. Other concerns with natural ventilation included patient comfort due to uncontrolled wind driven ventilation and air quality, particularly in winter when windows would be closed.

Therefore, the sole use of mechanical ventilation was explored, again using thermal modeling.

Mechanical Ventilation

The recommended air change rate for single rooms in SHTM 03-01 Appendix 1 Table A1 for single rooms is 6 air changes per hour (ac/h).

Modelling was carried out based on this recommendation, but it was found that the requirement of 26°C could not be met. To try to achieve this, the ventilation rate was further increased, but became excessive and likely to cause draughts to the occupants, poor temperature control and increased energy consumption.

Consideration was then given to a terminal cooling solution, using active chilled beams which provide cooling, heating and fresh air via the primary air supply system. The performance of chilled beams is related to their physical size and thus the amount of primary air supplied from the central air handling plant. The primary air volume will also

provide make up for the extract from the ensuite toilets to achieve a negative inflow of air into the bedroom from the corridor as required by SHTM 03-01 Appendix 1 Table A1 .

Using active chilled beams delivers the temperature control requirement, provides individual room control and fresh air, albeit less that the recommendation of SHTM 03-01.

Chilled beams are also an energy efficient solution and save some 9kg/m^2 of CO_2 over that of an all air system delivering 6ac/h, equivalent to about 10% of the hospitals' total emissions.

Conclusion

If natural ventilation could be employed then the air change rates within the bedrooms would be variable dependant on window opening and external conditions, and is rarely likely to achieve 6ac/h.

The recommended air change rate of 6ac/h in the SHTM is considered to relate to the ability to achieve an acceptable internal environment, i.e 50 hours exceedence above 28°C. This could be achieved with 6ac/h of cooled air.

However, the Board's requirement for a reduced temperature makes this solution impractical and the use of chilled beams is the only viable solution, using a reduced quantity of primary air.

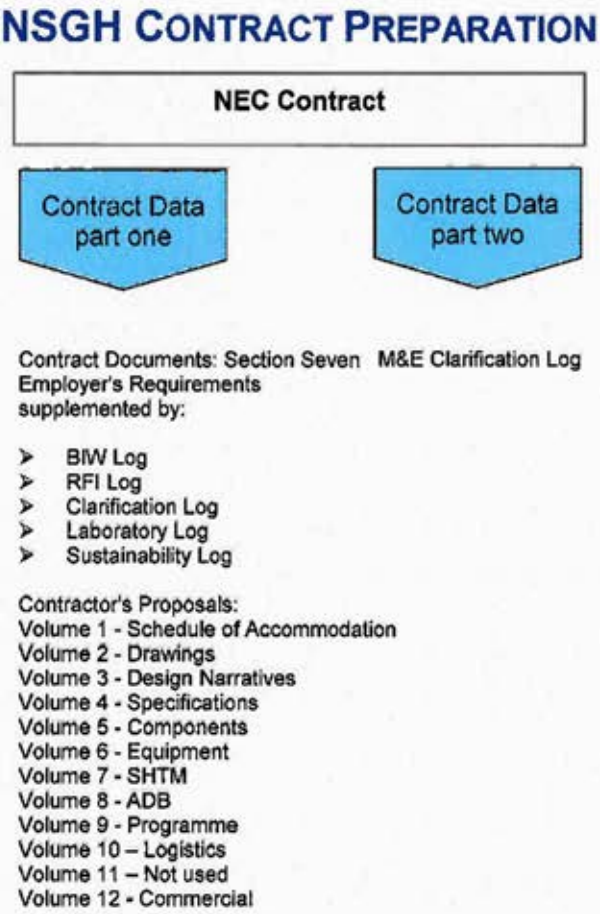
Whilst the air change rate is less than the SHTM, at a supply air volume of 30 litres per second it is in compliance with Scottish Building Regulations and also CIBSE codes, giving sufficient fresh air for a continuous occupation of three people at 10-12 litres per second each.

Appendix 5 to Contract Data part one: Works Information agreed relationship and hierarchy

NSGH Contract Data Part One and Part Two: Works Information
Agreed relationship and hierarchy

The contract is arranged such that the contract includes Contract Data part one and Contract Data part two. The Works Information will be wholly contained in Contract Data part one with the exception of the M&E items contained in the M&E Clarifications Log. The Works Information therefore will be in two parts and contained in Contract Data part one and Contract Data part two.

The output requirements of the Employer in relation to the M&E Clarifications Log will be contained in the Employer's Requirements with the proposals of the Contractor in relation to the M&E Clarifications Log contained in the Contractor's Proposals Volume 1 to Volume 10 set out in Contract Data part one. The contents of Works Information is illustrated below.



It is agreed that the Employer's Requirements takes precedence over the Contractor's Proposals, with the requirements of the Employer's Requirements to be met by the Contractor as a minimum requirement. The exception to this stated hierarchy is in relation to the items contained in the M&E Clarifications Log (found in Volume 3 of the Employers Requirements), which identifies the agreement between the parties in relation to the requirement for certain M&E items. All other aspect of M&E design require to achieve the standards and other requirements stated in Contract Data Part One.

In order to maintain an audit trail of the status of the documents to be included in the Employer's Requirements throughout the procurement process, the Employer's Requirements in Contract Data part one is supported by a Building Information Warehouse ("BIW") Log, Request for Information ("RFI"), Additional Log and Clarifications Log (collectively known as "the Logs") which track and identify the agreed position between the parties in relation to certain technical matters and documents and identifies the documents included in the Works

Information. In the event of a discrepancy between any item in the Employer's Requirements in the Employer's Requirements and that item in the Logs, the information contained in the Log takes precedence and the standard set out in the Logs is to be achieved by the Contractor. Further, the BIW Log identifies aspects of the original technical information which set out the Employer's Requirements (issued with the Invitation to Participate in Competitive Dialogue) which are included or omitted from the Employer's Requirements as well as providing similar clarity in respect of the other documents and information that was uploaded to Building Information Warehouse during the period up to the issue of the Invitation to Submit Final Bids.

The process for review of design to be submitted by the Contractor in relation to Contractor's Proposals to ensure that it meets the Employer's Requirements is appended to this document as Appendix A. The Works Information contained in both Contract Data Part One and Contract Data Part Two have been signed by the parties to identify their acknowledgement that such documentation is included in the Contract. The drawings referred to in the drawing register included in the Works Information which is signed by the parties, are deemed to be incorporated in and form part of the Contract by reference without having to be signed individually.

This document is 'The M & E Clarification Log (2010 ItP) – FINAL'

Item	Add	Omit	Board Comment	Status	Brookfield Comment	Board Comment 2	Agreed Position 2009 Contract	2010 ItP Comments	Agreed Position 2010 ItP
ER 2/1									
Text	-	-	Volume 2/1 of the ERs remains as the output requirements of the Board to be achieved as a minimum standard by the Contractor. Including M&E appendices 1, 2, 3, 4, 5, 6 & 7.	**Agreed**	Needs to be replaced by Brookfield contractor's proposal drawings in so far as these drawings are in conflict to the ER`s or the Works Information 2 should take precedence over Works Information 1 if this is ultimately how the Board wish to encompass the final contract documents. A schedule of derogations is to be produced.	Volume 2/1 of the ERs remains as the output requirements of the Board to be achieved as a minimum standard by the Contractor. Including M&E appendices 1, 2, 3, 4, 5, 6 & 7. except as described in this design summary which reflects the agreed position on the items therein.	**Agreed**	Board Comment 2 (agreed position in relation to 2009 Contract) stands with any additional alternative compliance agreements captured in The 2010 Instruction to Proceed Log and the M&E clarification log (2010 ItP).	**Agreed**
Drawings	-	-	The ER drawings remain as the output requirements of the Board. The submitted bid drawings of BC supplement the ER drawings and the following system comments are provided to assist in resolving certain anomalies within BC proposals.	**Agreed**	Needs to be replaced by Brookfield contractor's proposal drawings in so far as these drawings are in conflict to the ER`s or the Works Information 2 should take precedence over Works Information 1 if this is ultimately how the Board wish to encompass the final contract documents. A schedule of derogations is to be produced.	The ER drawings remain as the output requirements of the Board except as described in this design summary which reflects the agreed position on the items therein.	**Agreed**	The ER drawings remain the output of the Board to be met by BCL. The BCL drawings in relation to M&EAppendix 1 are noted as representing the developed design for this aspect of the requirement. The overall developing design status and intent is contained in Appendix K in Folder V of The 2010 Instruction to Proceed Log.	**Agreed**
Bid Submission – Vol 2 Drawings									
Chilled Water	-	-	The chillers to incorporate free cooling coil sections or equivalent provision.	**Agreed**	We have centralised the chillers to a single energy centre to optimise resilience and benefit from absorption cooling. Free cooling' chillers are not appropriate, however, high efficiency 'turbo core' chillers using magnetic free field bearings are proposed to maximise energy efficiency	Based upon examples of previous installation locations, the Board accept the use of 'turbo core' chillers	**Agreed**	All items in this Section as per 'Agreed Position 2009 Contract' i.e. no change in status for 2010 ItP	**Agreed**
	-	-	Plate heat exchangers to be fully independent duty/standby including wiring and control panels etc.	**Agreed**			**Agreed**		
	-	-	Chillers to have screw compressors, "Rated as residentially quiet".	**Agreed**	Chillers will use oil free 'turbo core' compressors (magnetic free field bearings) Noise levels will be within site boundary constraints.		**Agreed**		
	-	-	Chillers to have variable speed head pressure control with load and efficiency optimized head pressure and chilled water flow temperature control to improve seasonal efficiency will be	**Agreed**	Typically one manufacturer of Turbo core chillers offers a product that "utilizes EC fan technology" coupled with floating head		**Agreed**		

			incorporated.		pressure to enhance part load chiller efficiency. The PLC control system integrates fan speed, head pressure and compressor control to optimize chiller efficiency during periods of low ambient temperature and reduced cooling load." Chillers selected already have high Co-efficient of Performance				
	-	-	Full system details and drawings to be provided for specialist areas (Plant required to ensure max feed water temp of 5 to 12 deg C to specialist areas noted in correspondence during CD)	**Agreed**	Brookfield is currently unclear as what this refers to. System configurations and operating temperatures will be applicable to the application.	Stage 2 design development to demonstrate compliance.	**Agreed**	All specialist areas and systems will be addressed in the Stage 3 Design Development.	**Agreed**
	-	-	Reduction in Chiller Plant resilience where (N+1) N=8 is not agreed, provision of additional unit together with associated distribution pipework and controls required to comply with ER's.	**Agreed**	N+1 resilience is provided and includes the absorption unit. All as identified within Brookfield Contractors Proposal Volume 3 Cooling Design Strategy 3.33.	N+1 resilience accepted by the Board	See attached email identifying extent of N+1 (e-mail from Ross Ballingall dated 14 December 2009)		

Ventilation	-	-	Typical Isolation Room Supply. All air system heater battery +5°C to 21°C – supply temperature will require to be higher for provision of room heating.	**Agreed**			**Agreed**	All items in this Section as per 'Agreed Position 2009 Contract' i.e. no change in status for 2010 ItP	**Agreed**
	-	-	Pressure stabiliser to be located in the wall above the bedroom door to the lobby. Currently indicated within ductwork in the ceiling void, no access in this location due to ceiling construction.	**Agreed**	A review will be undertaken so that jetting draughts through Pressure Stabiliser does not cause discomfort to bedded patient.		**Agreed**	To be demonstrated during Stage 3 Design Development.	**Agreed**
	-	-	Conventional Theatre Supply System Schematic. Air on temp to cooling coil to be +30°C ER's, not 28°C as shown on BE drawing (Also main heater battery within AHU to be rated at +6°C to 35°C).	**Agreed**			**Agreed**		
	-	-	Typical Ultra Clean Theatre Supply air on temp to cooling coil to be +30°C ER's, not 28°C as shown on BE Drawing (Also main heater battery to be rated at +6°C to 35°C).	**Agreed**			**Agreed**		
	-	-	Typical Isolation Room Extract Schematic. All air system heater battery +5°C to 21°C – Supply temperature will require to be higher for provision of room heating.	**Agreed**			**Agreed**		
	-	-	Typical Conventional Theatre Extract System Schematic Air on temp to cooling coil to be +30°C ER's, not 28°C as shown on BE drawing (Also main heater battery within AHU to be rated at +6°C to 35°C).	**Agreed**			**Agreed**		
	-	-	Typical Ultra Clean Theatre Extract System Schematic Air on temp to cooling coil to be +30°C ER's, not 28°C as shown on BE drawing (Also main heater battery within AHU to be rated at +6°C to 35°C).	**Agreed**			**Agreed**		
	-	-	Ward Air change to be 6AC/HR, currently shown as 2.5AC/HR which is not in compliance with SHTM 03-01.	**Agreed**	Brookfield proposal as outlined within the bid submission is to incorporate chilled beams as a low energy solution to control the environment which do not rely on large volumes of treated air or variable natural ventilation. All accommodation is single bedrooms and therefore the need for dilution of airborne microbiological contamination should be reduced (rooms could also be at slightly negative pressure to		**Agreed** The proposal is accepted on the basis of 40 litres per second per single room (8 litres per second per second) for one patient and four others. Joint review to be carried out between the Board and Brookfield of the	Energy model based on the agreed 2009 position.	**Agreed**

					corridor). Providing 6 air changes is energy intensive and not necessary.		energy model to determine any impact on the energy target/BREEAM rating. Brookfield, however, remain responsible for achievement of the energy target/BREEAM, with £250,000 added to the contract sum in this regard. Negative pressure to be created in the design solution.		

Hot & Cold Water Services	-	-	Renal Water Schematic to be reviewed by SGH Renal Water Advisory Group and comments incorporated within the scheme.	**Agreed**			**Agreed**	All items in this Section as per 'Agreed Position 2009 Contract' i.e. no change in status for 2010 ItP	**Agreed**
	-	-	Renal Acid Circulation Schematic to be reviewed by SGH Renal Water Advisory Group	**Agreed**			**Agreed**		
	-	-	Renal Water System response to Volume 2/1 , Appendix M&E 6 Renal Water is to be completed and approved by NSGH Renal Water Advisory Group	**Agreed**			**Agreed**		
	-	-	Concentrate Bulk Delivery to site Strategy is to be completed and approved by NSGH Renal Water Advisory Group	**Agreed**			**Agreed**		
	-	-	Stainless Steel pipework to be provided as per ER's in lieu of ABS plastic for the larger sizes.	**Agreed**	63mm dia and above will use Stainless Steel pipe. 50mm dia below will use ABS plastic pipe.	Stainless Steel pipework to be provided for all sizes.	**Agreed**		
	-	-	24 Hour water storage to be provided in lieu of 12 hours as proposed and modularity of tanks to be as per the ER's. (if we change to 12 hours, change to 4 tanks)	**Agreed**	However this requires further discussion since the project has two diverse incoming water supplies and thus Brookfield consider our proposal to be the most economic solution.	Board considering ZBP calculations for 24 hour capacity, dated 08 December 2009	700m^3 water storage to be provided		

Heating Systems	-	-	3 no. off flow pipes to be provided between the Energy Centre and the Hospitals capable of passing 50% flow through each, where one fails and the other two can carry the total load. Current proposal is to reduce to 2 no. off pipes each capable of carrying 66% should one fail.	**Agreed**	Brookfield proposal is based on capacity for each A and B service rated at 66% each.	Brookfield considering how to provide 100% resilience most efficiently. Proposals to be provided.	Agreed that 3 sets all running at 50% to be provided. These are to be design and installed to provide a resilient system, such that a failure/burst in one set will not affect another set, with each set able to be accessed (excavated) for repair or maintenance without affecting or impeding the other sets. In this regard, should a 'single trench' system be proposed, clear separation of sets within separate compartments in the trench to be provided.	All items in this Section as per 'Agreed Position 2009 Contract' i.e. no change in status for 2010 ItP	**Agreed**
	-	-	Plate heat exchangers to be fully independent duty/standby including wiring and control panels etc.	**Agreed**					
Medical Gases	-	-	Medical gas schematic to be amended to reflect ER requirements together with the BC plant room services layout drawing and design dialogue.	**Agreed**	Medical gas schematic is in compliance with SHTM02.01		**Agreed**	All items in this Section as per 'Agreed Position 2009 Contract' i.e. no change in status for 2010 ItP	**Agreed**
	-	-	All references to BOC should be Air Products Ltd.	**Agreed**			**Agreed**		
	-	-	Details of the plant resilience for Medical Air, Oxygen, Vacuum, Surgical Air, Nitrous Oxide and Nitrous Oxide to be in accordance with the ER's.	**Agreed**	Medical gas is in compliance with SHTM02.01	Medical Gas resilience also to comply with ER's including for example Board's specific requirement for two VIE installations	**Agreed**		
Wet Riser Schematic	-	-	Water storage tank capacity to be with local authority.	**Agreed**			**Agreed**	Wet riser replaced by dry risers.	**Agreed**
	-	-	BC drawings to be developed.	**Agreed**	Part of stage 2 design activities.				
Sprinkler Schematic	-	-	Note on BC drawing states ' Tank by Others ' to be clarified as included.	**Agreed**			**Agreed**	All items in this Section as per 'Agreed Position 2009 Contract' i.e. no change in status for 2010 ItP	**Agreed**
	-	-	Note on BC drawing states ' Others to include tank immersion heater, trace heating, lighting etc. to be clarified as included.	**Agreed**			**Agreed**		
	-	-	Note on BC drawing states Pump House by others to be clarified as included.	**Agreed**			**Agreed**		

Energy Centre	-	-	Man access to be provided to the chimney stack to allow full access to flues over its total height as ER's.	**Agreed**			**Agreed**	All items in this Section as per 'Agreed Position 2009 Contract' i.e. no change in status for 2010 ItP	**Agreed**
	-	-	Chimney stack enclosure to be provided.	**Agreed**	Brookfield proposal includes an open frame structure		**Agreed**		
			Boiler layout to be configured to simplify flue routes.	**Agreed**	Part of Stage 2 detailed design activities if practical.		**Agreed**		
	-	-	External oil transfer point to be provided on the wall of the Energy Centre to serve the retained estate.	**Agreed**			**Agreed**		
	-	-	Minimum requirement is accessible diverse twin trench solution to be provided in accordance with the ER's to provide required resilience. Pipe material selection will be critical	**Agreed**	Part of Stage 2 detailed design activities if practical	Minimum requirement is to provide physical separation of resilient services route, ie separate primary from back-up	This may be achieved by separation within a single trench (see response in relation to Heating Systems, above, for clarity of separation requirement).		
Plant Replacement Strategy	-	-	Scaffold platform to be capable of supporting the plant weights of the larger items of equipment or other strategy adopted to minimise plant replacement time.	**Agreed**	Part of Stage 2 detailed design activities		**Agreed**	All items in this Section as per 'Agreed Position 2009 Contract' i.e. no change in status for 2010 ItP	**Agreed**
	-	-	Ground finishes to be capable of taking the scaffolding weight with plant added adjacent to plantrooms.	**Agreed**	Part of Stage 2 detailed design activities		**Agreed**		
UPS	-	-	UPS autonomy to be amended in line with the ER's.	**Agreed**	Superseded by agreed RFI log.	Board to review Theatre UPS requirements.	1 hour in Theatres, 30 minutes elsewhere. **Agreed**	All items in this Section as per 'Agreed Position 2009 Contract' i.e. no change in status for 2010 ItP	**Agreed**
Lighting	-	-	Lighting control to be amended inline with ER's.	**Agreed**	Superseded by agreed RFI log. Refer to contractors proposal.		**Agreed**	All items in this Section as per 'Agreed Position 2009 Contract' i.e. no change in status for 2010 ItP	**Agreed**
	-	-	Full luminaire details to be provided including LED's and feature lighting.	**Agreed**			**Agreed**		
	-	-	Bedside lights to be low energy type.	**Agreed**			**Agreed**		
	-	-	Feature lighting LED's to be provided inline with the ER's.	**Agreed**			**Agreed**		
	-	-	BE lighting design strategy to be applied to the Internal Lighting scheme which shall be developed in line ER's to provide full CIBSE compliance.	**Agreed**			**Agreed**		
	-	-	Lamp colour strategy to be developed in line with HSE & CIBSE guidance	**Agreed**			**Agreed**		
	-	-	External Lighting scheme to be developed in line ER's with full CIBSE compliance.	**Agreed**			**Agreed**		

Comms Room Racks	-	-	Reduction in racks is not agreed, ie. 10 indicated by BE in each main Comms Room to be amended inline with the ER's drawing.	**Agreed**	Rack number will be as the ER's	Number of racks to be as ER drawing	**Agreed**	All items in this Section as per 'Agreed Position 2009 Contract' i.e. no change in status for 2010 ItP	**Agreed**
	-	-	Comms room cooling strategy to be detailed to minimise energy use.	**Agreed**	Part of Stage 2 detailed design activities.				
Fire Alarm	-	-	Graphic user interface system details to be provided during detailed design	**Agreed**	Part of Stage 2 detailed design activities.		**Agreed**	All items in this Section as per 'Agreed Position 2009 Contract' i.e. no change in status for 2010 ItP	**Agreed**
	-	-	BE to provide full details of the proposed voice alarm system and indicate areas to be covered by conventional sounders	**Agreed**	Part of Stage 2 detailed design activities.		**Agreed**		
	-	-	Atrium protection system details to be provided	**Agreed**	Brookfield confirm that a Double knock fire detection only will be provided. Atrium is provided with ETFE roof covering which includes a hot wire system and therefore no other protection systems should be required.	All systems will be provided to meet the building control and fire engineering solution.	**Agreed**		
	-	-	Comms room VESDA system details to be provided	**Agreed**	Part of Stage 2 detailed design activities		**Agreed**		
Structured Data Wiring	-	-	Comms room and rack layouts to be provided for early discussion with GG&C Technology to verify equipment space allocation.	**Agreed**	Part of Stage 2 detailed design activities		**Agreed**	All items in this Section as per 'Agreed Position 2009 Contract' i.e. no change in status for 2010 ItP	**Agreed**
Metering	-	-	All metering to be provided in accordance with ER's to allow active energy management together with associated BREEAM credits.	**Agreed**	Metering has been included to CIBSE TM39 with provision for fitting future metering to individual department as required (i.e. stool sections in pipe and a BMS connection point).	BE to provide proposal to meet ER requirement including potential use of portable active monitoring.	Brookfield proposal agreed, supported by ZBP Metering Strategy December 2009.	All items in this Section as per 'Agreed Position 2009 Contract' i.e. no change in status for 2010 ItP	**Agreed**
Energy Management	-	-	Energy Management software to be fully compliant with ER's complete with BMS management and interactive link to GG&C system	**Agreed**	Part of Stage 2 detailed design activities		**Agreed**	All items in this Section as per 'Agreed Position 2009 Contract' i.e. no change in status for 2010 ItP (design development of this aspect will be monitored during Stage 3)	**Agreed**
Standby Power	-	-	BE to provide early proposals for system management, CHP and Utility Company interface details to progress agreement of all parties	**Agreed**			**Agreed**	Part of Stage 3 Design Development	**Agreed**
Bio fuels	-	-	BE to advise outcome of their proposed feasibility study and provide detailed proposals	**Agreed**	Brookfield advised that a further investigation would be made into the use of biogas if supply was made available to Board from the sewage water treatment operator. Biofuel was investigated and found not feasible.	Please provide details of the review in report format for overview.	Post Contract	Board to advise during Stage 3 should Biofuel become a requirement. Design provides 'T' connections for potential future integration with a biofuel system/solution.	**Agreed**

Utiliities	-	-	BE to provide design estimates for water, gas and electricity to verify and update Utility company info .	**Agreed**			**Agreed**	These have been provided in relation to Water and Electricity, Gas to be provided.	**Agreed**
Service reserve capacity Electrical Utilities Estimated Loads	- -	- -	BE to ensure that service reserve capacity is maintained during detailed design MVA Requirement varies from ER	**Agreed** **Agreed**		Quotation is for 24 MVA and this is acceptable	**Agreed**	All items in this Section as per 'Agreed Position 2009 Contract' i.e. no change in status for 2010 ItP	**Agreed**
As fitted drawings, asset register and O&M's	-	-	BE to ensure that all systems shall be linked to the As Fitted drawings via MiCAD drawing mapping, the MiCAD should also integrate with the LMS to provide a fully integrated system complete with interfaces to the PPM and Board's labour resource software systems (Apollo or Eclipse).	**Agreed**	Agreed as detailed in Brookfield Contractors Proposal Vol 3 Completion Strategy 3.24	Confirm that a full operating system will be provided with all of the requested operational activities and working links.	Confirmed that ER requirement will be met.	All items in this Section as per 'Agreed Position 2009 Contract' i.e. no change in status for 2010 ItP	**Agreed**
PPM	-	-	BE to provide, as part of the contract, a full PPM manual and system (computer based software package) for all the buildings and for all building and building services elements of the project. This system will incorporate the As Fitted drawings (MiCAD format) and specifications. This schedule shall have a full planned maintenance programme of works that the FM & Estates managers can review to plan and establish their annual maintenance schedules and annual budgets. BE will be responsible for the purchase and installation of the full PPM system, including pc work stations, barcode readers and tablets.	**Agreed**	Agreed as detailed in Brookfield Contractors Proposal Vol 3 Completion Strategy 3.24	Confirm that a full operating system will be provided with all of the requested operational activities and working links.	Confirmed that ER requirement will be met.	All items in this Section as per 'Agreed Position 2009 Contract' i.e. no change in status for 2010 ItP	**Agreed**
General Items	-	-	BE drawings will require further development to meet ER requirements.	**Agreed**	Part of Stage 2 detailed design activities		**Agreed**	Continued activity as part of design development.	**Agreed**
	-	-	Vibration and noise solutions to be included on drawings.	**Agreed**	Part of Stage 2 detailed design activities		**Agreed**	Continued activity as part of design development.	
	-	-	Weather proofing to be in accordance with ER's.	**Agreed**	Part of Stage 2 detailed design activities		**Agreed**	Continued activity as part of design development.	
	-	-	All plant sound attenuation measures to be shown.	**Agreed**	Part of Stage 2 detailed design activities		**Agreed**	Continued activity as part of design development.	
	-	-	All plant tagging to be in compliance with ER's.	**Agreed**	Part of Stage 2 detailed design activities		**Agreed**	See The 2010 Instruction to Proceed Log - in Folder S	
	-	-	Compliance with ER's to be demonstrated for all plant and systems maintainability and area isolation.	**Agreed**	Part of Stage 2 detailed design activities which will comply with CDM regulations.		**Agreed**	Continued activity as part of design development.	
	-	-	Leak detection to be incompliance with	**Agreed**			**Agreed**	Continued activity as part of design development +	

			ER's.					specifics in The 2010 Instruction to Proceed Log and Critical Failures to address Theatres etc	
	-	-	All clinical areas with special emphasis on Operating Theatres, Radiology, MRI and Critical Care to be configured to miminise risk of water damage from plant and equipment. All plantrooms to be treated for mitigation of water leaks in accordance with the ER's.	**Agreed**			**Agreed**	Continued activity as part of design development + specifics in The 2010 Instruction to Proceed Log and Critical Failures to address Theatres etc	
	-	-	Environmental proving of all rooms to be provided in accordance with the ER's. Samples and reliance on BMS only for test results is not acceptable.	**Agreed**	Part of commissioning and handover		**Agreed**	As per 'Agreed Position 2009 Contract' i.e. no change in status for 2010 ItP	
	-	-	All services elements to be included to meet the buildings Fire Engineering solution, eg. Stair Pressurisation, Smoke Control etc. all in accordance with the ER's and to the requirements of building Control.	**Agreed**			**Agreed**	As per 'Agreed Position 2009 Contract' i.e. no change in status for 2010 ItP	
	-	-	Dual path distribution resilience to be provided for all services in accordance with the ER's.	**Agreed**	For agreed extent of dual paths for electrical services refer to RFI log, (RFIs 031 & 068).	Not agreed. Heating, Chilled water, controls and BMS must have dual path distribution resilience. All piped services including CWS & HWS must be configured to ensure minimum disturbance to services. Refer to paragraphs in section 8.1.3 and 8.1.5 etc.	Agreed that dual path distribution relates to electricity and all water systems (e.g. chilled water, CWS & HWS, heating etc)	As per 'Agreed Position 2009 Contract' i.e. no change in status for 2010 ItP. See also The 2010 Instruction to Proceed Log	
	-	-	BMS IP network to be fully stand alone with all active equipment will be included. BMS to be fully compliant with ER appendix M&E5.	**Agreed**			**Agreed**	As per 'Agreed Position 2009 Contract' i.e. no change in status for 2010 ItP	
	-	-	All Mechanical, Electrical, Public Health and Specialist System plant to be designed and installed in modular arrangements incorporating plant N+1 redundancy to minimize disruption during planned maintenance in accordance with the ER's.	**Agreed**	Not possible in all cases to do this. (S)HTMs in some cases will not allow for example: HWS systems.	Not accepted. All plant to be N+1. In respect of the specific item the BE bid has 2+1 service units for the HWS which is acceptable	Generally all plant will come N+1. On HWS agreed that an extra pump be provided for quick change if required	As per 'Agreed Position 2009 Contract' i.e. no change in status for 2010 ItP	
	-	-	BE to provide detailed backup to justify plant selection e.g. Capital Costs Lifecycle & Maintenance Costs Additional Electrical etc loadings Projected Energy costs etc	**Agreed**	Part of Stage 2 detailed design activities		**Agreed**	Continued activity as part of design development.	
			BE shall develop the sustainability brief in conjunction with the Local Authority to ensure compliance with: Building Regulations, BREEAM Healthcare Excellent	**Agreed**	As detailed in contractors proposal and Part of Stage 2 detailed design activities		**Agreed**	Continued activity as part of design development.	

			requirements, Building Control, Glasgow City Council requirements Scottish Government Planning Policies including SPP6 Advice Notes including PAN84 NHS/Board objectives.						
Bid Submission – Vol 3 Strategy									
Text [ref]			Comments Incorporated within drawing and ER items above.						
Bid Submission – Vol 4 Specifications									
Spec [ref]			Detailed construction specification to be provided as part of the design review process	**Agreed**			**Agreed**	Appendix K information submitted and reviewed, specifications will continue to develop as design is progressed. Current status included in Folder V.	**Agreed**
Bid Submission – Vol 5 Components									
Component [ref]			Capacities, rating, spare capacity all to be confirmed to reflect accurate building geometry and dimensions during detailed design. List to be expanded to include all ancillary plant e.g. pressurisation units, water filtration plant, fuel systems, wet risers, sprinklers, controls, data wiring, data wiring accessories, racks, power distribution, lighting controls, Structured cabling, nurse call, fire alarms, transformers, luminaire details and BMS etc. Three manufacturers for each plant type to be agreed for all Mechanical, Electrical and Public Health equipment prior to contract execution.	**Agreed** **Agreed**	Agreed list included in Volume 5 of Contract Data Part 2		**Agreed** Agreed list included in Volume 5 of the Contractor's Proposals in Contract Data Part 1	Updated agreed list included in Folder H1 of the 2010 Instruction to Proceed	**Agreed**
Bid Submission – Vol 6 Equipment									
Generally			as part of the design review process						
Bid Submission – Vol 7 SHTM									
Generally			Compliance to be demonstrated during the detailed design	**Agreed**			**Agreed**	All items in this Section as per 'Agreed Position 2009	**Agreed**

								Contract' i.e. no change in status for 2010 ItP	
Bid Submission – Vol 8 ADB									
Generally									

sypro

New Southern General Hospitals

Project Management Instruction Report

Notify

ID	370	**Notified by**	GGC01.pmoir on 23/06/2010 16:18:51
Notified to	BCL01-Brookfield Construction Limited	**Date notified**	23/06/2010
Date response required	07/07/2010		
Title	PMI/General/021 - HAEMATO-ONCOLOGY WARD		
Description	Alteration to Board requirements for M&E Services		
Instruction	The Board confirm that 8 No single rooms no longer require Hepa filter air supply as originally specified. The current Nightingale layout reflects the Board's requirement for room split between Haemato-oncolgy beds and the remainder of the ward. Please provide an indication of the cost saving to remove the additional filtration to the 8 No rooms and ensuites. This PMI picks up items in NHS/EW 007 & 008.		
Status	None	**Cancel PMI**	None

Meeting

Documents

Notes

Sypro Contract Manager

New Southern General Hospitals

Compensation Event #5056

Status: Closed

Notification

Notified By

GGC01.NSGLP.pmoir on 16 Sep 2010

Notified To

BCL01

Proposed Compensation Event?

No

Under Dispute?

No

Type

60.1(1)-Change to the Works Information

Title

Adult Hospital - Haemato-Oncology Ward Air Filtration CEN 014

Description

Board confirm change to their requirements for HEPA filter provisopn to 8 No single room wards in HA ward. Refer PMI/General/021 Sypro ID No. 370.

Linked to Early Warning

6954 - NHS/EW/008 - Oncology Ward - Specialist Ventilation

Is Early Warning Appropriate?

Yes

Reply By

7 Oct 2010

Decision

Request to submit quotation

Quotation Request Assumptions

Please provide a quotation for removal of the above equipment.

Quotation #1

Proposed Cost

[redacted]

Accepted Programme affected?

No

Delay to the Completion Date?

No

Delay to a Key Date?

No

Alteration to Accepted Programme?

No

Quote Response Assumption

above quote is nett of overhead and profit

Quotation Submitted By

on

Reply By

30 Sep 2010

Outcome

An acceptance of a quotation

Outcome Comments

N/A

Assessment / Implementation

Proposed Changes to Price

[redacted]

Proposed Changes to Completion Date

N/A

PM Agreed Changes to Price

[redacted]

PM Agreed Changes to Completion Date

NHS Greater Glasgow and Clyde Health Board

New South Glasgow Hospitals Project

Environmental Matrix

November 2010

ISSUE	DATE	BY	CHECKED	COMMENTS
1	15.11.10	JNB/BR/DW	RK/JB	First Issue

WALLACE WHITTLE

Mechanical, Electrical and Public Health Consulting Engineers
8 Elmbank Gardens, Glasgow, G2 4NQ
Telephone 0141 221 9866
Facsimile 0141 221 6088
Email: glasgow@wallacewhittle.com
www.wallacewhittle.com

INVESTOR IN PEOPLE

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CONTENTS

DRAFT ZBP RESPONSES
2/12/10

Executive Summary

The matrix appears to represent a reasonable assessment of the requirements for the given criteria for the selected rooms.

There are various anomalies, these should be reviewed with the Contractors team and either updated in the matrix or scheduled for incorporation into the contract documentation.

1.0 Introduction

Wallace Whittle were requested by Currie and Brown UK Ltd. to review the building services data entries within the Contractors Environmental matrix for NHS Greater Glasgow and Clyde Health Board.

The report highlights areas that do not appear to be in compliance with the Employer's requirements (ER's) and the various anomalies have been cross referenced to the relevant items within the ER's.

2.0 Documentation

The matrix was received as electronic file reference V2 -_ na_cbexportofme_data_ 100928_ REVIEWEDBYZBP dated 14 October 2010.

The Employer's requirements are as detailed in ER Volume 2/1 Section 8 and the associated M&E appendices.

3.0 Matrix Parameters

We understand that the matrix parameters and list of rooms were provided by the Board to Brookfield and that the 720 rooms are a representative sample of the overall project.

4.0 Derivation of Response to M&E Parameters

We understand from discussions with ZBP that the responses to the parameters have generally been derived as follows:

4.1 Temperature: Winter

Derived generally from SHTM 03-01 Appendix 1. However, temperatures of 18°C appear low for patient areas and 21 °C has generally been used. For staff only areas 20 °C is used. Local room controls will allow this to be adjusted down if desired. Specialist areas, e.g. isolation rooms, do have some variation from this.

4.2 Temperature: Summer

Upper temperature limit generally derived from SHTM 03-01 Appendix 1, however, the ERs limit to 26 °C not 28 °C, and HTM Clause 2.11 has been applied for hours of exceedance. Diagnostic rooms generally limited to 25 °C. Note Aseptic Suite currently shown as 23 °C and not 22 °C as SHTM.

4.3 Temperature Notes

Item for recording any particular comments.

4.4 Relative: Humidity

No humidity control specified except Aseptic Suite and in specialist diagnostic rooms where equipment type makes this a requirement.

4.5 Ventilation: Extract

Generally to match supply requirement and provide any required room pressure difference. Small extract rates (less than 25 l/sec) may be taken through door leakage.

4.6 Ventilation: Supply

Derived generally from SHTM 03-01 Appendix 1. Bedrooms are as agreed at 40 l/sec and office type spaces are at 10 l/sec per person as required by ERs (but do not meet BCO level of 12 l/s).
Air change rates stated are minimums and subject to final heat load assessments to maintain space temperature.

4.7 Mechanical Ventilation Notes

Item for recording any particular comments.

4.8 Ventilation: Relative Pressure

Generally as defined in SHTM 03-01 Appendix A. However, bedrooms are to be negative to corridors. Elsewhere ventilation will be to a balanced pressure.

4.9 Ventilation: Dust Spot Efficiency

Item for recording removal of fine particles found in external air.

4.10 Ventilation: Arrestance (Filtration)

Generally as defined in SHTM 03-01, however all plant will be provided with a minimum of grade F7 final filtration.

4.11 Filtration Humidity Notes

Item for recording any particular comments.

4.12 General HVAC Notes

Item for recording any particular comments.

4.13 Lighting: Service Illumination Lux

Lighting levels derived from LG2 (general lighting schedule, table 1), CIBSE Code for Lighting (lighting schedule, section 2.5) and BS EN 12464-1:2002 (schedule of interiors, section 5.3).

4.14 Lighting: Service Illumination Lux Notes

Details of working plane and supplementary information derived from LG2 (general lighting schedule, table 1), CIBSE Code for Lighting (lighting schedule, section 2.5) and BS EN 12464-1:2002 (schedule of interiors, section 5.3).

4.15 Lighting: Service Illumination Night Lux

Lighting levels, where applicable, derived from LG2 (general lighting schedule, table 1), CIBSE Code for Lighting (lighting schedule, section 2.5) and BS EN 12464-1:2002 (schedule of interiors, section 5.3).

4.16 Lighting: Service Illumination Night Lux Notes

Details of working plane and supplementary information, where applicable, derived from LG2 (general lighting schedule, table 1), CIBSE Code for Lighting (lighting schedule, section 2.5) and BS EN 12464-1:2002 (schedule of interiors, section 5.3).

4.17 Lighting: Illumination Local Lux

Lighting levels, where applicable, derived from LG2 (general lighting schedule, table 1), CIBSE Code for Lighting (lighting schedule, section 2.5) and BS EN 12464-1:2002 (schedule of interiors, section 5.3).
Provision of local illumination determined in tandem with client requirements, and provision of, examination lamps on 1:50 room layouts.

4.18 Lighting: Illumination Local Lux Notes

Details of working plane and supplementary information, where applicable, derived from LG2 (general lighting schedule, table 1), CIBSE Code for Lighting (lighting schedule, section 2.5) and BS EN 12464-1:2002 (schedule of interiors, section 5.3).

4.19 Lighting: Colour Rendering

Minimum lamp colour rendering requirements derived from LG2 (general lighting schedule, table 1), CIBSE Code for Lighting (lighting schedule, section 2.5) and BS EN 12464-1:2002 (schedule of interiors, section 5.3).

4.20 Lighting: Colour Rendering Notes

The value TRUE was entered for each space from the choice of TRUE or FALSE to permit consistency across all spaces. The Codebook definition for the TRUE and FALSE entries is unknown therefore TRUE was considered to indicate that a minimum colour rendering lamp Ra>80 is required for internal areas as derived from LG2 (general lighting schedule, table 1), CIBSE Code for Lighting (lighting schedule, section 2.5) and BS EN 12464-1:2002 (schedule of interiors, section 5.3).

4.21 Lighting: Standby Grade

Standby lighting grade defined in Lighting Guide 2 section 8.2. All lighting is backed up by the generators therefore all spaces are grade "A".

4.22 Lighting: Standby Lighting Grade Notes

Standby lighting grade defined in Lighting Guide 2 section 8.2.

4.23 Lighting: Illumination Notes

This section is treated as a general notes column to provide additional information. The lighting control defined as per LG2 (general lighting schedule, table 1). Unified glare rating limit derived from LG2 (general lighting schedule, table 1), CIBSE Code for Lighting (lighting schedule, section 2.5) and BS EN 12464-1:2002 (schedule of interiors, section 5.3). Default room surface reflective values for use in the lighting calculation are provided and the working plane heights for use in the lighting calculation as detailed in the service illumination notes column are detailed.

4.24 Noise design: Privacy Factor

Item for recording Acoustic parameters.

4.25 Noise design: Mechanical Services

Item for recording Acoustic parameters.

4.26 Noise design: Intrusive Noise

Item for recording Acoustic parameters.

4.27 Noise design: Noise Notes

Item for recording any particular comments.

4.28 Noise design: Acceptable Sound Level

Item for recording Acoustic parameters.

4.29 Noise design: Speech Privacy

Item for recording Acoustic parameters.

4.30 Noise design: Quality Not Tolerated

Item for recording Acoustic parameters.

4.31 Noise design: General Noise Notes

Item for recording any particular comments.

4.32 Safety: Hot Surface Temperature

Patient and public access will have accessible hot surface temperatures limited to 43ºC. Ceiling radiant panels will operate at a higher temperature but are considered to be inaccessible.

4.33 Safety: Hot Water Temperature

In accordance with SHTN 6, and in addition, staff wash facilities are provided with temperature limiting facilities.

4.34 Safety Temperature Notes

Item for recording any particular comments.

4.35 General Safety Notes

Item for recording any particular comments.

4.36 Fire: Fire Enclosure

Item for recording Fire Engineering parameters.

4.37 Fire: Fire Automatic Detection

The fire detection & alarm system being installed is a category L1 as defined within BS 5839-1:2002 section 5.1.3. Detector types have been selected in-line with the recommendations of BS5839-1:2002 section 21.

5.0 Comments on Matrix Response Derivations

The parameters appear generally in line with the Employers requirements with the following comments:-

		Action
5.1	**Temperature: Winter** Temperatures appear to be on the low side, refer to CIBSE Guide A Table 1.5 Wards/Consulting Treatment Rooms recommended comfort criteria is 22-24°C, current proposal is 21°C would increase to 23°C. Staff areas, we would increase from 20 to 21°C to ensure comfort, CIBSE recommend Nurses Station 19-22°C. All areas should be provided with user controls. This would all be inline with intention of M&E 3 para 2.4.4 Thermal Comfort.	Update design temperatures within the matrix
5.2	**Temperature: Summer** ER's clarification (see appendix A1 below) also states that room temperatures should not go higher than 26°C in summer for more that 50 hours in total, but not on successive days. External summer design temperature (26.2°C DB).	Confirm compliance with external temperature base and consecutive day requirement
5.3	**Temperature Notes** As 5.2	Update matrix
5.4	**Relative: Humidity** Confirmation required of the humidity provision and control within Aseptic Suite and diagnostic rooms. All in accordance with ITPD Vol. 2/1 paragraph 8.2.11.13 & 8.2.13.1.	Confirm compliance
5.5	**Ventilation: Extract** There are various stores etc. with no ac/hr extract rate against them. Room extract rates to be taken as per SHTM Appendix 1 – Table A1, ITPD Vol. 2/1 paragraph 8.2.11.8 and ventilated in accordance with Building Control requirements.	Update matrix
5.6	**Ventilation: Supply** Office type spaces are at 10 l/sec per person as required by ERs which is inline with the SHTM and CIBSE.	No action
5.7	**Mechanical Ventilation Notes** No details.	

Matrix revised to accomadate

ZBP COMMENTS

AGREED TO REMAIN WITH TEMPERATURES CURRENTLY SHOWN ON MATRIX.

CONSECTIVE DAYS RELATES TO OUTSIDE TEMPERATURE PATTERN. THEREFORE, DESIGN WILLBE BASED ON A MAXIMUM OF 26°C AND CONTROLS ADJUSTED BY BOARD TO ALLOW 50 HOURS OF EXCEEDANCE TO SAVE ENERGY.

NOTED

ASEPTIC SUITE - CONFIRMED
AWAIT EQUIPMENT INFORMATION TO DETERMINE WHETHER HUMIDITY CONTROL IS REQUIRED.

WILL BE UPDATED.

5.8	**Ventilation: Relative Pressure**	
	ER's provide specific guidance in ITPD M&E3 paragraph 2.10 and section ITPD Vol. 2/1 paragraph 8.2.14 for Isolation Suites. Operating Theatre pressure regimes to be complied with.	Confirm compliance.
5.9	**Ventilation: Dust Spot Efficiency**	
	Information provided for Theatres only, suggest that this is provided for all AHU's.	Information to be provided in due course.
5.10	**Ventilation: Filtration**	
	ER's provide specific guidance in ITPD M&E3 paragraph 3.16 Main ICT server room filtration - G4 and section ITPD Vol. 2/1 paragraph 8.1.8.6 for appropriate filtration to reduce odours entering the facility.	Confirm compliance.
5.11	**Filtration Humidity Notes**	
	Information provided for sample areas. Notes also include reference to general ventilation.	Reference docs to include SHPN for isolation units. General notes move to general notes section.
5.12	**General HVAC Notes**	
	Very few entries.	Relocate general notes to this section.
5.13	**Lighting: Service Illumination Lux**	
	ER's paragraphs 8.3.3.11, 8.3.3.1.2 and CIBSE guide 2 items 3.11.6, 3.11.7 and 9.2 provide specific guidance on the use of LED's	Confirm compliance
5.14	**Lighting: Service Illumination Lux Notes**	
	As below	Refer to section 6
5.15	**Lighting: Service Illumination Night Lux**	
	CIBSE Code also give guidance on specific areas and overspill	Confirm compliance
5.16	**Lighting: Service Illumination Night Lux Notes**	
	As below	Refer to section 6

ZBP COMMENTS

COMPLIANCE CONFIRMED. IN ACCORDANCE WITH SHTN/SHTMS.

WILL BE COVERED IN SPECIFICATIONS FOR AHUS, BUT ALL AHUS WILL HAVE GRADE F7 FINAL FILTRATIONS.

F7 WILL EXCEED G4 REQUIREMENTS
CARBON FILTERS FITTED TO ALL AHUS.

NOTED.

NOTED

Compliance confirmed

—

Compliance confirmed

—

5.17	**Lighting: Illumination Local Lux**	
	CIBSE Code also give guidance on specific areas	Confirm compliance
5.18	**Lighting: Illumination Local Lux Notes**	
	As below	Refer to section 6
5.19	**Lighting: Colour Rendering**	
	Not provided	Add RA design values
5.20	**Colour Rendering Notes**	
	As below	Refer to section 6
5.21	**Lighting: Standby Grades**	
	ER's provide specific guidance in ITPD M&E3 paragraph 3.5 for lighting to areas of Clinical Risk Category 5 (IEE GN7 Group 1 and 2 areas) are provided with lighting at the same level as normal lighting, power shall be supplied by a UPS.	Update matrix
5.22	**Standby Lighting Grade Notes**	
	Comments as 5.21.	Update matrix
5.23	**Lighting: Illumination Notes**	
	No issues.	No action
5.24	**Noise design: Privacy Factor**	
	Non M&E item.	Review by others
5.25	**Noise design: Mechanical Services**	
	Noise criteria to be as ITPD Vol. 2/1 paragraph 8.1.10 Acoustics	No action
5.26	**Noise design: Intrusive Noise**	
	Non M&E item.	Review by others
5.27	**Noise design: Noise Notes**	
	Non M&E item.	Review by others

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ZBP COMMENTS

Compliance confirmed

—

Codebook only permits the values "TRUE" or "FALSE" therefore the colour rendering values have been entered into the colour rendering notes column.

—

Update not required, refer to RFI log item 008.

As above

—

			ZBP COMMENTS
5.28	**Noise design: Acceptable Sound Level**		
	Non M&E item.	Review by others	
5.29	**Noise design: Speech Privacy**		
	Non M&E item.	Review by others	
5.30	**Noise design: Quality Not Tolerated**		
	Non M&E item.	Review by others	
5.31	**Noise design: General Noise Notes**		
	Non M&E item.	Review by others	
5.32	**Safety: Hot Surface Temperature**		
	Generally agreed, however particular consideration required in specialist areas including Schiehallion Ward to ensure compliance with design intent.	Confirm compliance	COMPLIANCE CONFIRMED
5.33	**Safety: Hot Water Temperature**		
	41 deg C limit noted for public / patient areas	No action	
5.34	**Safety Temperature Notes**		
	Safety note to be provided at all water outlets above 41 deg C	Update matrix	MATRIX WILL BE UPDATED.
5.35	**General Safety Notes**		
	No issues	Relocate hot warning items to relevant column	NOTED.
5.36	**Fire: Fire Enclosure**		
	ER's para 8.3.4.6 and M&E app3 items 2.4.2 & 3.8 confirm that all M&E services are configured to ensure compliance with the fire strategy and building regulations particularly in respect of sleeping accommodation.	Update matrix	THIS IS NOT AN M&E ITEM. SERVICES WILL COMPLY WITH FIRE STRATEGY.
5.37	**Safety: Fire Automatic Detection**		
	The fire ER's provide specific guidance in ITPD Vol. 2/1 paragraph 8.3.4 and M&E3 paragraph 3.8 on the use of high sensitivity smoke detecting aspirating systems to supplement Analogue Addressable Coverage.	Confirm compliance	ZBP to review environmental matrix to ensure compliance with ITPD Vol. 2/1 paragraph 8.3.4 and M&E3 paragraph 3.8. Covered in ZBP Fire Alarm & Detection System Performance Specification.

6.0 Specific Comments and Matrix Examples

The matrix includes several non building services items these, have been highlighted in the preliminary response.

The following table has been compiled to indicate items which require to be clarified. Example rooms have been identified, however the comment relates to all similar room types.

Item	Heading	ITPD vol 2/1	Reviewing Engineer's Comments	Example Rooms (comment applies to all appropriate rooms)
1	Service Illumination lux notes	8.1.12.4 and CIBSE guide LG2 para 3.11.1 & 3.11.2.	Confirm lighting levels in cd/m² for all ward and bedroom areas are in compliance with CIBSE LG2 recommendations.	Rooms: B0607A, B1602B2, B0616A, B0308A
2	Service Illumination lux notes	8.1.12.4 and CIBSE guide LG2 para 3.11.7 & 3.12.	Confirm observation lighting levels for each type of ward/unit are in full compliance with CIBSE LG2 recommendations.	Rooms: B0607A, B1602B2, B0616A, B0308A
3	Service Illumination notes	8.1.12.4 and CIBSE guide LG2 para 3.11.1 & 4.5.4.	Confirm lighting levels for trolley/recovery areas will have 500lux at any point on trolley and a maximum lighting level not exceeding recommendations within CIBSE LG2 section 3.11.1.	Rooms B2417BB, B2406C, B2409C, B2409C1
4	Service Illumination notes	8.1.12.4 and CIBSE guide LG2 para 3.11.3 & 3.11.4.	For wall and ceiling mounted reading lights, confirm bed head levels covered are within an area of 1m x 1m from centre of pillow towards bottom of bed have 300lux and a uniformity of not less than 0.5 as recommended by CIBSE	Rooms B0607A, B0308A, B0305A3, B0305A2

ZBP COMMENTS

Item 1 - Lighting design will be in compliance with CIBSE LG2.

Item 2 - ZBP to review illumination levels to ensure compliance.

Item 3 - Lighting design will be in compliance with CIBSE LG2.

Item 4 - Lighting design will be in compliance with CIBSE LG2.

Item	Heading	ITPD vol 2/1	Reviewing Engineer's Comments	Example Rooms (comment applies to all appropriate rooms)
5	Illumination notes	8.3.3.2, 8.3.3.15 & 8.3.26.1 and app M&E3 para 3.4	Confirm lighting control philosophy for each area is in compliance with CIBSE recommendations LG2. Areas shown at present appear to be generic.	Rooms B2417BB, B2406C, B2409C, B2409C1
6	Service Illumination Local lux	LG2 para 3.11.3	Confirm ward and room areas lighting levels around bed area for examinations when curtains are drawn are in compliance with CIBSE LG2.	Rooms B0607A, B0616A, B0308A
7	Service Illumination Local lux	LG2 para 3.11.5	Confirm night light levels are in compliance with CIBSE LG2 for different types of ward units and rooms. Confirm also night lights are LED type and night light levels on pillow do not exceed 0.5 lux.	Rooms B305A, B0607A, B0305A3, B180202
8	Service Illumination Local lux	LG2 para 3.14	Confirm additional lighting levels for ICU, CCU and HDU including switching control areas are in compliance with CIBSE LG2 section 3.14.7.	Rooms B0616A, B0602B, B0308A, B1602C
9	Standby Lighting Grade	8.3.30.2 and App M&E3 para 3.5	It has been noted that grade A has been utilised for all areas within rooms This is greater than CIBSE LG2 and BSEN 12464 and ER documentation recommend for certain areas. Why is this and how is this to be implemented? Also confirm percentage of luminaires to be on standby for each room/area.	Rooms; C0235B, C0235B1, C0235B2, C02237B3.

ZBP COMMENTS

Item 9 -

Item 8 -

Item 7 -

Items 5 + 6 - Lighting design will be in compliance with CIBSE LG2. LED night lights will be considered but can't be confirmed at this time.

ZBP to review illumination levels to ensure compliance.

All lighting will be backed up by standby generators therefore all areas will be considered grade A.

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Item	Heading	ITPD vol 2/1	Reviewing Engineer's Comments	Example Rooms (comment applies to all appropriate rooms)
10	Colour Rendering	7.6.5 and App M&E3 para 3.4	It has been noted that the term True has been utilised for all rooms. Please confirm what this term represents.	Rooms; 14, B0305A, B1602B2, B1802C1
11	Colour rendering notes	7.6.5 and App M&E3 para 3.4	Confirm colour temperature of lamps for all areas and confirm that appropriate IP ratings will be selected for luminaires to suit the room environment.	Rooms C0201A1, C0107C1, C0230C, B2409C1
12	Colour Rendering Notes	8.3.3.3.1.15	It is noted that a number of rooms under column Colour Rendering Notes. Have Ra of ≥ 80, the ER document has requested ≥ 85, albeit this figure ≥ 80 is in compliance with CIBSE LG2 and BS 12464 for certain areas/rooms.	Rooms; E0305A, E0206C, E0311A1, C1401B
13	Noise items other than for Mechanical Services.	-	Outwith M&E services.	
14	General noise notes	-	Item has been populated with comments regarding lighting controls. Remove lighting notes and highlight any anomalies.	
15	Safety Hot surface Temperature	8.2.7	Protection by distance not acceptable in specialist accommodation areas	Confirm compliance

ZBP COMMENTS

Item 10 - Nightingale Architects are specifying the glazing. Refer to section 4.20, codebook only permits the values "TRUE" or "FALSE" therefore the colour rendering values have been entered into the colour rendering notes column.

Item 11 - Colour temperature of lamps will be in accordance with CIBSE LG2 and luminaires will be selected with the appropriate IP rating.

Item 12 - Agreed, ZBP will update the matrix as necessary.

Item 14 - This is not consistent with spreadsheet provided by ZBP. Nightingales to verify output from codebook.

Item 15 - Please advise "Specialist Accommodation Areas".

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Item	Heading	ITPD vol 2/1	Reviewing Engineer's Comments	Example Rooms (comment applies to all appropriate rooms)
16	General Safety Notes	-	Entries to be updated in accordance with detailed design requirements and items relating to caution hot water moved to the appropriate column.	
17	Fire enclosure	SHTM03	Entries to be updated to identify all Fire hazard rooms and proposals for all sleeping accommodation.	Sleeping accommodation B0305, B0305A etc.
18	Fire Automatic Detection	App M&E3 para 3.8	Entries to be updated to differentiate between normal and aspirated detection. e.g. including Theatres, X-ray, MRI, and ICT rooms and all other 'specialist suites'.	N0106B, N0106B1 & N0108A
M1	Noise Design Mechanical Services	8.1.10	Noise design from Mechanical Services has not been indicated for all rooms, the maximum noise from plant shall be as indicated in the ER's.	B0305A, C0230C, C0701A, C0701A2
M2	Mechanical Ventilation Notes	SHTM 03-01	Ventilation rates to be indicated for all rooms in compliance with the ER's.	D0114A, D0455A, D0815A, 40336C
M3	Dust Spot Efficiency	SHTM03-01 4.123	Provide information in due course for all AHU's filtration.	Provided for N0106B, N0106B1 & N0198A
M4	Temperature Notes	Clarification (see appA1)	ER's clarification (see appendix A1 below) also states that room temperatures should not go higher than 26°C in summer for more that 50 hours in total, but not on successive days. External summer design temperature (26.2°C DB).	All conditioned spaces

ZBP COMMENTS

Item 18 - Covered in ZBP Fire Alarm & Detection System Performance Specification. ZBP to review Matrix to ensure compliance.

Item 17 - Not a services issue. - Refer to Fire Strategy drawings.

Item M1 - Acoustic Logic issue.

Other items will be addressed as Matrix Updated.

Item	Heading	ITPD vol 2/1	Reviewing Engineer's Comments	Example Rooms (comment applies to all appropriate rooms)
M5	Temperature Summer	Clarification (see appA1)	Upper level temperature items to be indicated for all rooms or "none" indicated if none proposed.	All conditioned spaces
M6	Temperature Notes	Clarification (see appA1)	Compliance required	B0308A & B0607A
M7	Temperature Notes	Clarification (see appA1)	(25 deg C is as CIBSE but may be greater than supplier's recommendations.) Battery life is dependant on temperature, please confirm that temperature will be in accordance with manufacturer's recommendation to maximise battery life.	K0107B & K0116A
M8	Temperature summer	Clarification (see appA1)	Summer temperatures are not given for various rooms.	C1401B, D0114A, F0410A, J1110A
M9	Ventilation Relative pressure	8.2.14	Ventilation relative pressure is no given for various rooms.	B0607A1, CH1, C0302A2 & C1401B
M10	Ventilation	8.2.11.7 8.2.11.8	Ventilation details have not been completed for all rooms.	C0302A2, C1401B
M11	Ventilation Notes	General	Reference to BSEN ISO 14644 parts 14, 16 & 18 is queried. Do these parts exist?	10282, 10371 & 10380

ZBP COMMENTS

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ZBP COMMENTS

7.0 Summary

The electronic format of the information is difficult to print, review work has been screen based. Anomalies have been found and these are highlighted within sections 5 and 6.

ZBP COMMENTS

8.0 Conclusions

The matrix appears to represent a reasonable assessment of the requirements for the given M&E criteria for the selected rooms. The various anomalies should be reviewed with the Contactors team and agreed responses integrated within the package.

ZBP COMMENTS

Removal of Mandatory Maximum Temperature Variant.

The maximum temperature variant has been removed from the bid requirements, the bidders shall put forward schemes to ensure thermal comfort and avoid overheating.

Sustainability has a major input into the project and all solutions must seek to minimize CO_2 and energy usage, however this must not be at the expense of thermal comfort and avoidance of over heating.

For design purposes the level of thermal comfort shall be:

Room temperatures should not go below 18 °C in winter for longer than 2 hours at a time, or higher than 26°C in summer for more that 50 hours in total, but not on successive days.

Feasibility studies are to be carried out into the potential use of low and zero carbon technologies to reduce carbon emissions associated with the operation of the building.

The bidder's attention is drawn to the Employers Requirements and In particular the following sections:

Appendix M&E3
Paragraph (Extracts)

2.4.3 Chilled Beams

The use of active chilled beams should be considered within all ward areas.

Active chilled beams will provide tempered, filtered air together with heating and comfort cooling of the space; thus providing effective local control of the environmental conditions.

2.4.4 Thermal Comfort

High levels of comfort are required for all users; in particular staff and patients.

Openable windows can be used as part of the ventilation strategy, and it is necessary to ensure that other, often contradictory requirements such as restricting openings for safety reasons, are met.

In perimeter spaces where mechanical ventilation is provided for functional reasons a mixed mode approach is a possible solution.

ZBP COMMENTS

2.4.5 General Chilled Water

Sustainable cooling shall be used where possible with conventional chilling (with free cooling coils) used as required as a top up and to provide system resilience, all lower carbon means of supplying cooling such as bore holes, piling systems and absorption chilling must be fully investigated and chosen if there is a carbon advantage over conventional cooling.

Chillers shall be selected to operate at design duty with an external ambient temperature of 30°C dry bulb.

Chillers to have variable speed head pressure control with load and efficiency optimized head pressure and chilled water flow temperature control to improve seasonal efficiency.

3.1 External Design Temperatures

Summer	*26.2°C DB*	*18.5°C WB*
Winter	*- 6°C*	

Global warming potential shall be considered and the Contractor shall provide suggestions for dealing with this under the innovation section of the tender return documents.

Appendix M&E2
Paragraph (Extracts)

2.3 Cooling Load

The Cooling requirement shall be developed by the Contractor for the ~~standard and max temp mandatory variant~~ bids, all cooling shall be provided by the most efficient method including, absorption chillers, free cooling etc.

5.0 25% uplift for power to main hospitals.

ZBP COMMENTS

Section 8
Paragraphs

8.1.7 Thermal Comfort – (full contents)

8.1.8 Air Quality – (full contents)

8.2.11.3 The need to maintain the specified comfort conditions in all areas but particularly in clinical areas is of paramount importance and the Contractor shall develop strategies for achieving the specified environmental conditions with minimum energy consumption.

8.2.11.5 It is essential that the Contractor designs and provides ventilation and air conditioning systems which will ensure occupants comfort. This shall be achieved by use of well tested design principals and suitable plant selection. Air flow problems must be avoided by accurate system balancing, correct selection and location of air diffusers to prevent high air velocities and stratification together with adequate air volumes and accurate temperature control.

8.2.11.8 Air changes shall be in accordance with CIBSE guides, SHTM's, HTM's and Building Regulations.

8.2.11.10 Ensure heat gain from all Equipment and personnel is allowed for in sizing and selection of the systems.

8.1.25 In accordance with Good Industry Practice, all plant, plant spaces and building services systems shall be specifically designed and provided with defined reserve capacity allowances and future expansion capabilities for the Facilities (e.g. distribution boards with 25% spare capacity, 25% additional containment, 25% spare capacity in distribution Pipework, 25% additional plant capacity, 25% additional cooling capacity, 25% additional air handling capacity etc. for the buildings as designed).

CONTRACT MANAGER

New Southern General Hospitals

Project Manager Instruction #2062

Status: Accepted

Notification

Raised By

GGC01.NSGLP.sfrew on 2 Jul 2013 5:58PM

Raised To

BCL01

Response Required By

16 Jul 2013 12:00AM

Title

PMI 228 - Change to NSGH Level 4 - hepa filtration

Description

Further to the drawings and information previously provided by Heather Griffin identifying changes to NSGH level 4 the Board request that: a) BMCL stop the fit out works in this area b) BMCL provide an assessment of the works already carried out in this area c) BMCL and NHS to develop the design detail utilizing the RDD process in order to come to a design within the £700k (inc OH&P) as currently identified by BMCL. Initial design meetings with HGriffin can commence w/c 8th July 2013

Instruction

As above

New Southern General Hospitals

Project Manager Instruction #2073

Status: Accepted

Notification

Raised By

GGC01.NSGLP.pmoir on 8 Jul 2013 10:01AM

Raised To

BCL01

Response Required By

22 Jul 2013 12:00AM

Title

PMI 231 ADULT AND CHILDRENS HOSPITAL - COMMISSIONING & HANDOVER

Description

The Board confirm amendments to the requirement for an Independent Commissioning Engineer.

Instruction

The Board acknowledge the request for a change to the ER requirement in relation the ﷺindependenceﷺ of the engineer on the basis that the current BMCE staff have a detailed knowledge of the complex installations and are best placed to undertake the role. Refer attached document.

Documents

Document Name

PMI 231.docx

Description

PMI 231 text

File Type

application/vnd.openxmlformats-officedocument.wordprocessingml.document

Uploaded

On 8 Jul 2013 by GGC01.NSGLP.pmoir

DIRECTORATE CHANGE CONTROL PROCEDURE
NEW SOUTH GLASGOW HOSPITAL AND LABS PROJECT

NHS Greater Glasgow and Clyde

Unique CCP Reference No:		Adult & Children's Hospitals

SECTION 1: INITIATION

Project Name:	Adult ☒	Children ☐	Labs ☐
Date CCP Raised:	19.06.13	Raised By:	Jonathan Best, Director, Regional Services
Date Decision Required By:	10.07.13		

SECTION 2: DESCRIPTION OF CHANGE AND BUSINESS JUSTIFICATION

Description of Change:

Changes to Haemato-Oncology and Renal (South West Ward Wing adjacent to Core G Fourth Floor) and the two isolation rooms in the Renal High Dependency Area

1. To Hepa filter ward area from bedrooms HOW-067 to bedroom RENW-190 to same standard as the current haemato-oncology ward.
2. Convert HOW-009 (currently Socialisation Space) to a bedroom and ensuite – requires Hepa filtration to the same standard as current haemato-oncology ward.
3. Form a single Nurse Base from HOW-045 Reception Base and HOW-070 Staff Base with a lobby separation similar to the standard ward.
4. Form breakthrough at Wheelchair Bay HOW-036, add hold-open fire door.
5. Create 2 further fire doors by the Clean Utility (as per standard ward).
6. Omit wall and double door in the corridor outside the 'Large Equipment Store' HOW-032.
7. Renal Ward – add Hepa filtration to isolation rooms and lobby and ensuite for RENW-046 and RENW-041.

Business Justification for Change:

1. To move national unrelated donor bone marrow transplant programme and regional related donor programme (and, potentially, national sibling donor programme, if agreed by BCEs) from Beatson WOSCC to a site with full ITU and HDU support 24/7.
2. To meet accreditation and clinical standards for delivery of cytotoxic chemotherapy for acute leukemia patients.

- Full paper attached

Enclosures:	☐ Drawing		☐ Narrative	☐ Budget Cost	
Authorised by Director:	JBEST *Print Name*	[redacted] *Signature*		REGIONAL *Directorate*	9/7/13 *Date*
Authorised by Chief Operating Officer:	[redacted] *Signature*		Date:	9.7.13.	

SECTION 3: IMPACT OF CHANGE

Time:	☐	Nil
Revenue Cost:	☐	Nil
Capital Cost:	☐	£840,000 (inclusive of VAT) – quote valid until Wednesday 10th July 2013
We recommend that the Total Sum should be:	Contained within Existing Budget ☐ Funded from within the Optimism Bias Sum ☐ Funded from Directorate Budget ☐ No change or effect to the project budget ☐	
Impact Assessed By:		Date Assessed:

SECTION 4: AUTHORISATION

Levels of Authority:	Value (£)	Assessed	Date
Project Manager	0 – 10k		
Project Director	10k -100k		
Executive Sub-group	100k – 1.5m		
Performance Review Group	> 1.5m		

PM to issue instruction to carry out the works if approved

Distribution: PM ☐ PD ☐ Executive Sub-group ☐ BCL ☐ Currie & Brown ☐

Unique CE Reference No:	

A47851278

Sypro Contract Manager

New Southern General Hospitals

Compensation Event #10675

Status: Closed

Notification

Notified By

GGC01.NSGLP.pmoir on 2 Oct 2013

Notified To

BCL01

Proposed Compensation Event?

No

Under Dispute?

No

Type

60.1(1)-Change to the Works Information

Title

CE 051. Adult Hospital - Level 4 Zones 512, 513 & 514 HEPA Filtration

Description

The Board confirm acceptance of proposals set out in PMI 228 and confirm the design and adaptations to this are should be taken forward and incorporated into the finished building by the contract completion date for Stage 3. The agreed value for these works is [redacted] excluding VAT.

Reply By

23 Oct 2013

Decision

Request to submit quotation

Quotation Request Assumptions

The agreed value for the works is [redacted] ex.VAT

Quotation #1

Proposed Cost

[redacted]

Accepted Programme affected?

No

Delay to the Completion Date?

No

Delay to a Key Date?

No

Alteration to Accepted Programme?

No

Quote Response Assumption

A47851278

N/A

Quotation Submitted By

on

Reply By

16 Oct 2013

Outcome

An acceptance of a quotation

Outcome Comments

N/A

Assessment / Implementation

Proposed Changes to Price

[redacted]

Proposed Changes to Completion Date

N/A

PM Agreed Changes to Price

[redacted]

PM Agreed Changes to Completion Date

Documents

Document Name

Haemato-Oncology Change Costing Summary rev G (October 2013).pdf

Description

Final Agreed Level 4 Haemato Oncology Quote

File Type

application/pdf

Uploaded

On 17 Oct 2013 by BCL01.NSGLP.jbailey

SOUTH GLASGOW UNIVERSITY HOSPITAL & ROYAL HOSPITAL FOR SICK CHILDREN

BUILDING USER GUIDE (FM)

Address	SGUH & RHSC Southern General Campus Govan Road Glasgow G51
Building user Guide Issue No.	FM 01
Date	23.01.15 (NA)
This Building User Guide should be kept at all times in:	FM Helpdesk
Prepared by	Brookfield Multiplex

CONTENTS - SECTIONS HIGHLIGHTED to be lifted straight from General User Guide

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5.3 ~~Hours of Operation~~Building Materials/Components

6.0 Transport Facilities & Service Yard Operation ~~– NHS – Mark McAllister to update section~~

6.1 Parking Bays & Cycle racks – Update on numbers required

6.2 Service Yard ~~- OK~~

7.0 Refit And Rearrangement Considerations

7.1 Re-fit Building / Building section ~~– BM (M&E – DP input)~~

7.2 Re-arrangement / Addition of Furniture ~~- OK~~

7.3 Handover Information – ~~BM – to update dates- JW~~

7.4 Major Changes to Building Services Installed ~~– OK~~

8 Reporting Provision

8.1 Reporting Procedures ~~- OK~~

8.2 Building Contacts ~~– NHS – KC to review and update as necessary~~

8.3 Maintenance & Defect Contacts – Contact information required here

8.4 Building operating Times ~~– NHS – KC to review and update as necessary~~

8.5 Health & Safety Issues ~~– NHS – KC to review and update as necessary~~

9 Training ~~– BM (M&E – DP input) on section~~

9.1 Compulsory Training

9.2 Additional Training

10.0 Links & References ~~– OK~~

11.0 General ~~– Section not applicable~~

12.0 SHUH & RHSC Specific Training ~~Laboratory Specific training OK~~

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INTRODUCTION

The Building User guide (FM version) for the SGUH & RHSC is intended to provide the Facilities management staff with a simple, quick and easy guide to the everyday functions of the building, in order to ensure a safe healthy working environment. It also allows ongoing building energy performance and major alterations to be recorded.

The FM User guide should be read in conjunction with the General User Guide and the Operation and Maintenance manuals provided on the Zutec database.

For a full description of how to operate and maintain the SGUH & RHSC, please refer to the Health & Safety File (including operation and Maintenance Manuals) on the Zutec database.

Please ensure that this guide is kept up-to-date and in a readily accessible (designated) position. It contains important information for anyone carrying out work on the building and its services.

BUILDING USER GUIDE UPDATES AND REVIEWS

The user guide should be reviewed on a six monthly basis and updated when changes to the structure, layout, fabric or services have been made. Any changes made to the user guide should be recorded on the table below.

REVIEW DATE	DESCRIPTION OF UPDATES	PAGES UPDATED / REMOVED	SIGNATURE
12.01.2015	GENERAL UPDATE OF 'DRAFT' DOCUMENT		TG
19.01.2015	SECTION 3 UPDATED		TG
23.01.2015	GENERAL UPDATE TO INCORPORATE NEW CONTENT FOR SECTIONS 1 AND 7.		TG

The report has been prepared in conjunction with members of the Design Team, as noted below: -

Principal Contractor	Brookfield Multiplex Hardgate Road Govan Glasgow G51 4SX www.brookfieldmultiplex.com
Architectural Lead Consultant	Nightingale associates 87-91 Newman Street London W1T 3EY
Civil & Structural Engineering	WSP UK Centurion Business Park 5 Seaward Place Glasgow G41 1HH
Building Services & IT Infrastructure	Wallace Whittle & Partners 8 Elmbank Gardens Glasgow G2 4NQ

1.2 BUILDING ACTIVITIES

FLOOR	DEPARTMENT	PHOTOGRAPH
L-1	FM SERVICES/FACILITIES PLANT SERVICES TUNNEL CONNECTION TO LAB BUILDING	Insert Details of Signage When Installed
LO	RECEPTION/WAITING AREAS OPD SUPPORT SANCTUARY (RHSC) OBSERVATION WARD (ADULTS) REHAB AND THERAPIES RADIOLOGY EMERGENCY DEPARTMENTS DECONTAMINATION UNIT ACUTE ASSESSMENT DISCHARGE LOUNGE (ADULTS) PATIENT SUPPORT RETAIL PHARMACY/DISPENSARY MEDICAL ILLUSTRATION PATIENT INFORMATION/FAMILY SUPPORT	
L1	CRITICAL CARE CCU RADIOLOGY THEATRES (RHSC) OPD (ADULTS) STROKE WARD SANCTUARY (SGUH) MDU NUCLEAR MEDICINE PRE-OP (SGUH) RESTAURANT & VISITORS DINING SPECIAL FEEDS	
L2	SCHIEHALLION WARD ANAESTHETIC OFFICES DAY CASE UNIT ASEPTIC SUITE ACUTE RECEIVING WARD (RHSC) PLANT/M&E SERVICES (RHSC THEATRES/SGUH CCW) THEATRES	

	MEDICAL PHYSICS TRANSPORT BASE (RHSC) ENDOSCOPY DERMATOLOGY WARD (SGUH) NSGH RENAL DIALYSIS (SGUH)	
L3	IN-PATIENT WARDS (RHSC) WARD SUPPORT (RHSC) NSGH HEALTH RECORDS STAFF ACCOMMODATION NCH RENAL DIALYSIS	
L4	DCFP (RHSC) PLANT/M&E SERVICES (RHSC) RENAL WARDS (SGUH) WARD SUPPORT (SGUH) HAEMO-ONCOLOGY WARD (SGUH)	
L5 – L11	GENERIC WARDS (SGUH) WARD SUPPORT (SGUH) PLANT/M&E SERVICES (RHSC)	
L12	NSGH PLANT/M&E SERVICES	
L13/14	EQUIPMENT STORE/PPE STORE HELIPAD (LEVEL 14/15)	

1.3 BUILDING PLANS/LAYOUTS

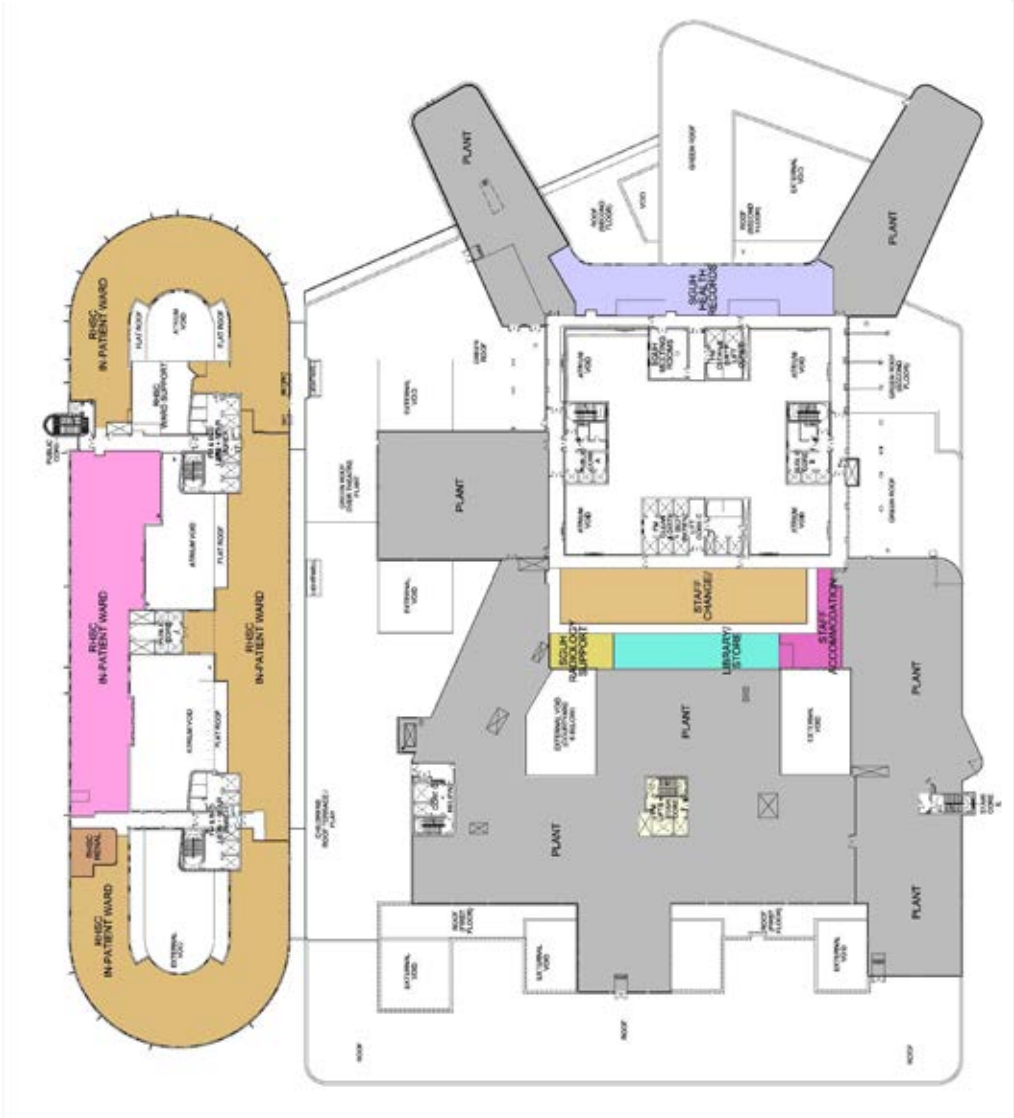
Level -1 Basement, FM services/facilities, Plant services, Tunnel connection to Labs building.

Level 0, Ground Floor: Reception/waiting areas, OPD, Support, Sanctuary (RHSC), Observation ward (SGUH) Rehab and Therapies, Radiology, Emergency departments, Decontamination unit, Acute assessment, Discharge lounge (SGUH), Patient support, Retail, Pharmacy/Dispensary, Medical illustration, Patient information/Family support.

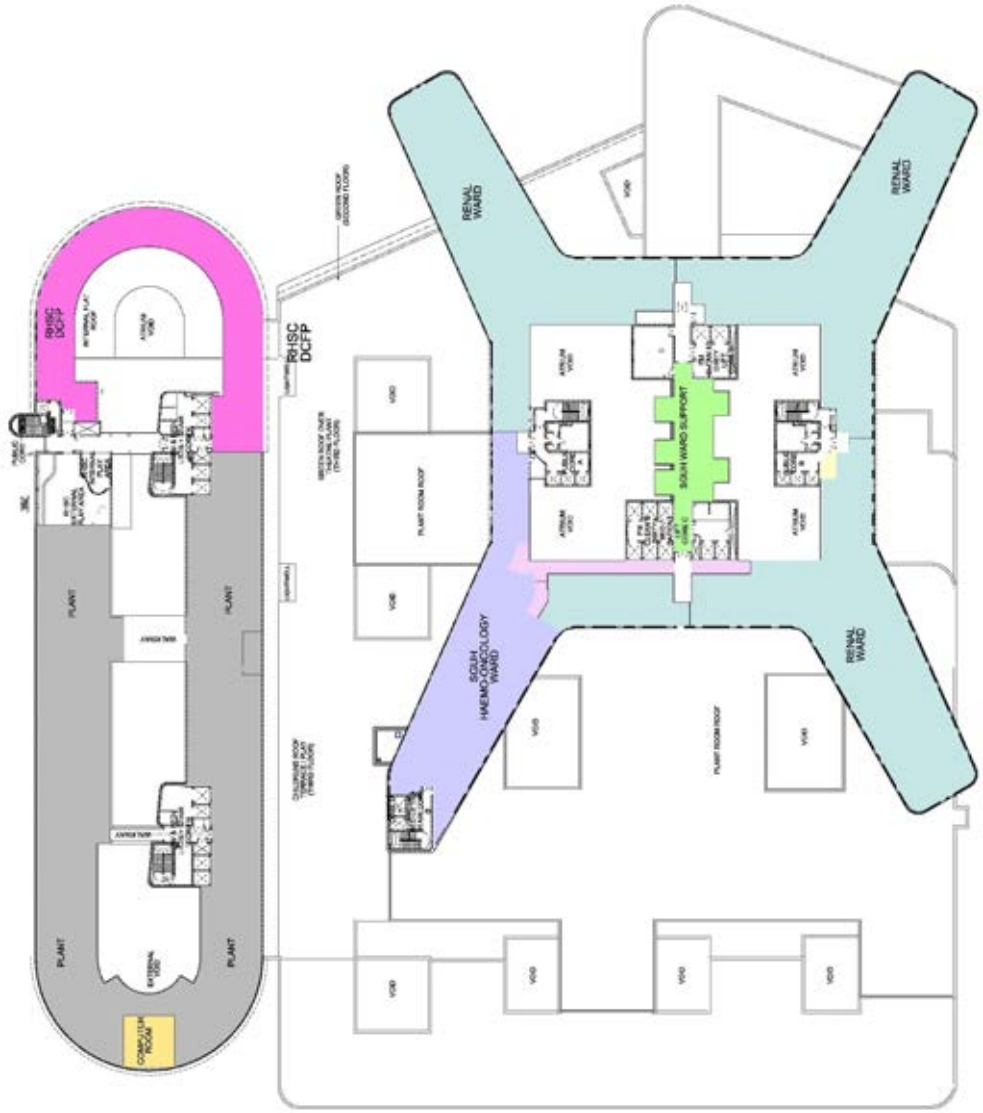
Level 1, Critical care, CCU, Radiology, Theatres (RHSC), OPD (SGUH), Stroke ward, Sanctuary (SGUH), MDU, Nuclear medicine, Pre-OP (SGUH), Restaurant & visitors dining, Special feeds.

Level 2, Schiehallion ward, Anaesthetic offices, Day care unit, Aseptic suite, Acute receiving ward, Theatres (SGUH), medical physics, transport base (RHSC), endoscopy, dermatology ward (SGUH), Renal dialysis (SGUH), Plant/M&E services (RHSC) theatres/CCW (SGUH).

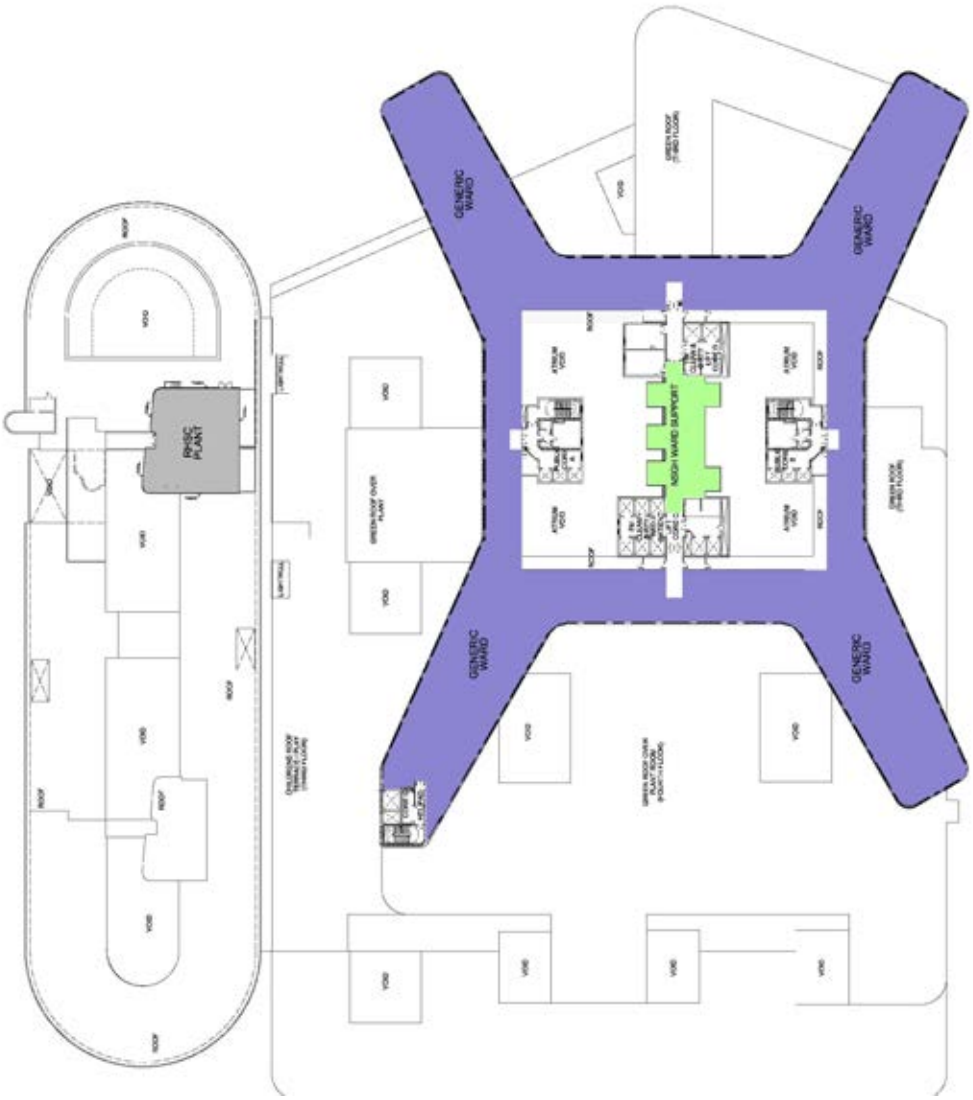
Level 3, In-patient wards (RHSC), Ward support (RHSC), Health records (SGUH), Staff accommodation, renal dialysis (RHSC).



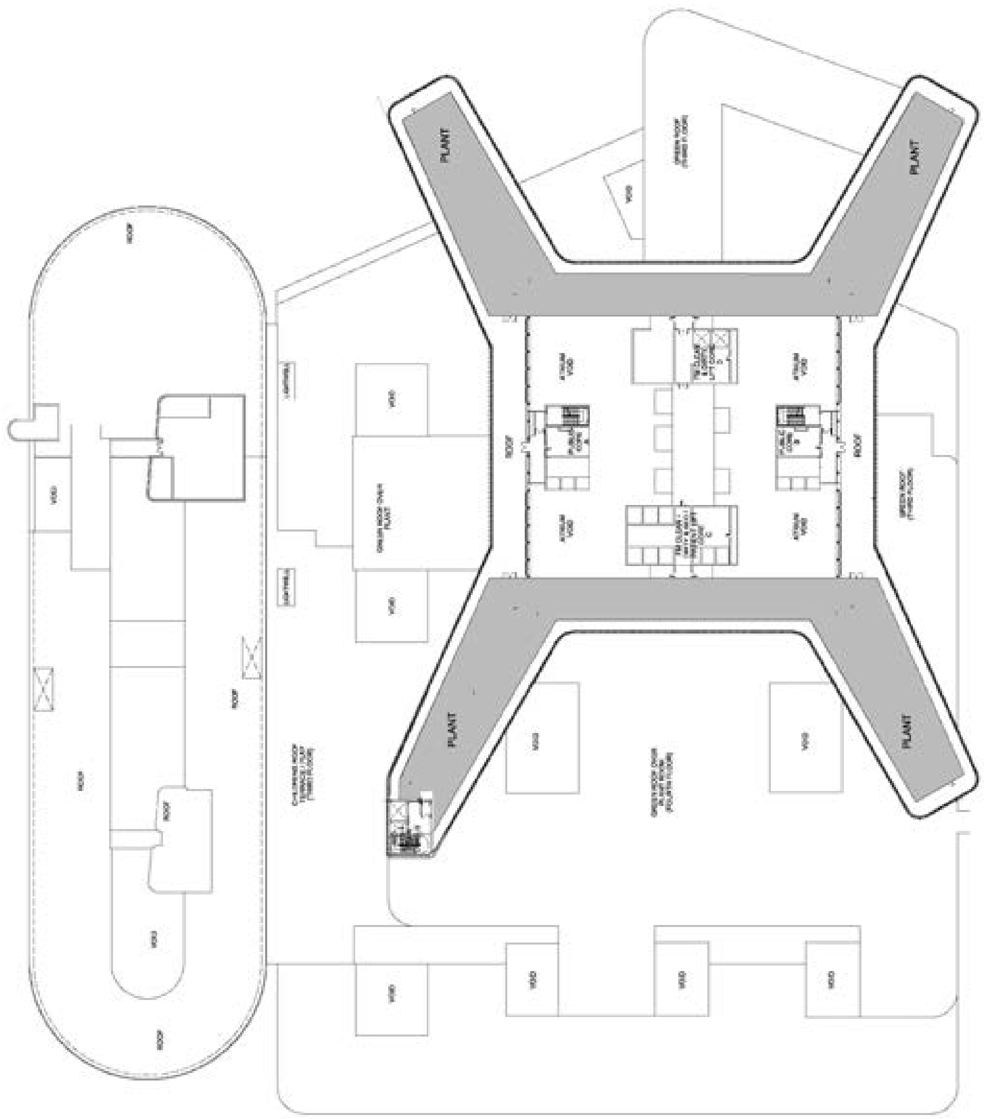
Level 4, DCFP (RHSC), Plant/M&E services (RHSC), Renal wards (SGUH), Ward support (SGUH), Haemo-oncology (SGUH).



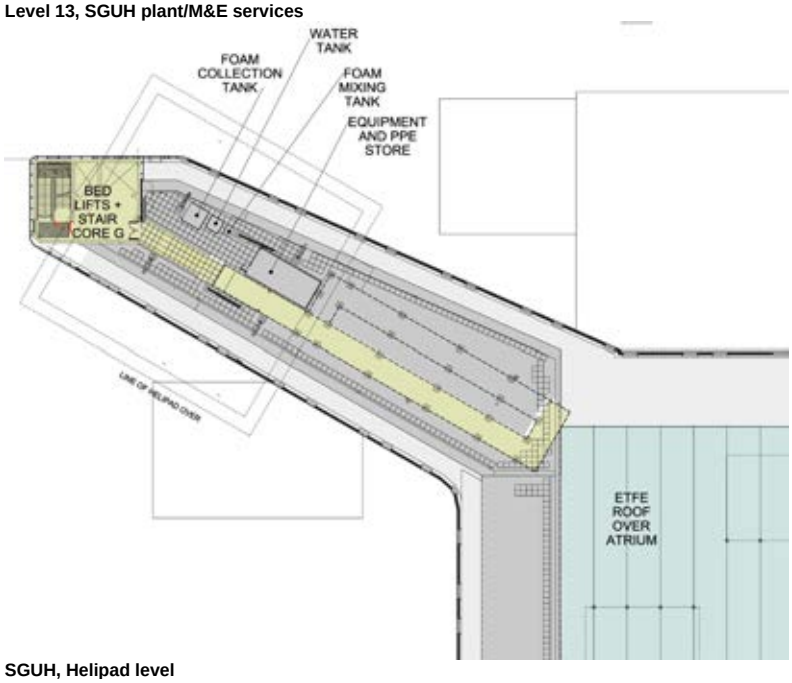
Level 5 - 11, Generic wards (SGUH), Ward support (SGUH), Plant/M&E services (RHSC)



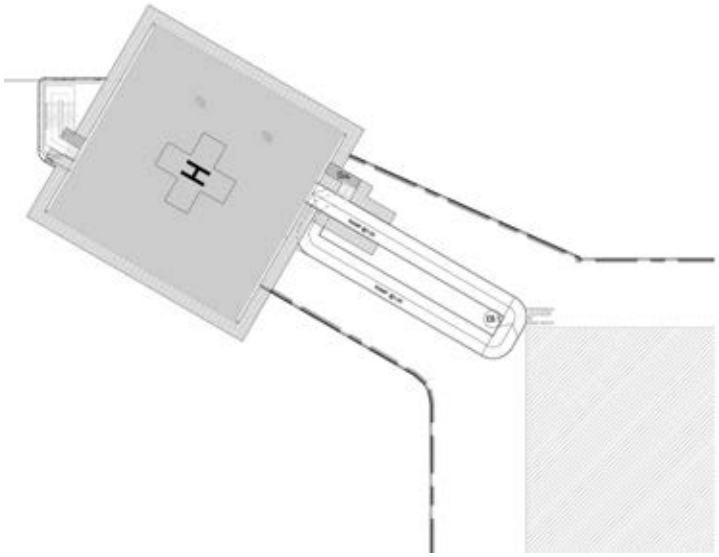
Level 12, Plant/M&E services (SGUH)



Level 13, SGUH plant/M&E services



SGUH, Helipad level



1.4 BUILDING MEASUREMENTS

Element	Area
Length	220.930m
Width	203.585m
Number of Floors	(Adults) Basement + 12 Floors (Childrens) 5 Floors

Levels	Area (m)	Volume (m^3)
Basement	7200	
Level 0 (Ground)	31100	
Level 1	28800	
Level 2	26050	
Level 3	17650	
Level 4	12485	
Level 5	7200	
Level 6	6050	
Level 7	6040	
Level 8	6035	
Level 9	6040	
Level 10	6025	
Level 11	6020	
Level 12	4990	

1.5 BUILDING INFORMATION

Building Description
The New Southern General Hospitals comprise of a new build 13 storey (including Basement level and a helipad at roof level to ward tower) 1109 bed adults and 4 storey 256 bed children's hospital, with a combined total floor area of approx. 171,000 m2. The structure is mainly concrete frame with a combination of external facade cladding used to enclose the building envelope, ranging from insulated metals panels, insulated render, stone cladding and integrated glazing units. The new building also link into existing Neuro science and maternity services via newly constructed external link bridges.
Internally the hospitals will provide A&E services and acute specialist care, as well as medical day services and out-patient clinics. The internal walls are generally constructed from metal stud drywall partitions, with fire and acoustic ratings as required. Floor coverings are hardwearing vinyl with floor tiling to both atria.

BUILDING ENVELOPE
South Glasgow University Hospital & Royal Hospital for Sick Children.

Description	As Built Performance
Louvres - PPC aluminium as NBS L10, double/triple banked as required and blanked/insulated as necessary.	Prater to confirm as built performance.
Windows - PPC aluminium double glazed units - generally full height with back-enamelled coloured panels where required, all as NBS L10	Prater to confirm as built performance.
Curtain walling - Stick' curtain walling system with back-enamelled coloured panels where required, all as NBS H11.	Prater to confirm as built performance.
Roof lights – Aluminium framed double glazing.	Prater to confirm as built performance.
Rendered external wall - Insulated Render system fixed to cementitious board substrate on metsec framing as NBS M21. First and Second floors on east and south elevations to adult podium. First, second, third floors to west and south façade of children's hospital. All courtyards.	Prater to confirm as built performance.
Stone cladding – Dunhouse Buff - to match existing Neonatal unit. Ground floor projection to north/north west facing façade of children's hospital. Ground, first, second floors of east, north and west (partial only) elevations to Adult OPD block.	Prater to confirm as built performance.
Facing blockwork cladding - Novastone - Buff as NBS F10 Ground floor to adult podium and ground floor to children's hospital.	Prater to confirm as built performance.

South Glasgow University Hospital & Royal Hospital for Sick Children.
(cont)

Description	As Built Performance
Curtain walling - unitised cladding - Unitised curtain walling full height with aluminium channel between floors and coloured back enamelled panels where required, all as NBS H11. All elevations to adult inpatient tower.	Structal UK to confirm as built performance.
External doors - PPC aluminium double glazed units (solid infill's to plantroom) - generally full height with back-enamelled coloured panels where required, all as NBS L10.	Prater to confirm as built performance.
High pressure laminate panel cladding – First, second, third, fourth, fifth floors to north (semi-circular) elevation of children's hospital.	Prater to confirm as built performance.
Aluminium composite panel cladding - Generally to plant room areas.	Prater to confirm as built performance.
Zinc Cladding – Zinc standing seam cladding as NBS H74 to First floor projection to north/north/west facing façade of children's hospital	Prater to confirm as built performance.
Aluminium Cladding – Aluminium rainscreen cladding as NBS H31 to lower areas of adult tower (first/second of north west wing) and to east and west faces.	Prater to confirm as built performance.
Aluminium Channel - Separating channel/'feature beam' between horizontal areas of render.	Prater to confirm as built performance.
Roofing - Ethylene Tetrafluoroethylene (ETFE) roof over adults and childrens atria.	Vector Foiltec to confirm as built performance.
Roofs – Light weight roofs Single ply membrane on rigid insulation boards.	Prater to confirm as built performance.
Extensive Green roof -	
Brown roof -	

1.6 MECHANICAL BUILDING SERVICES OK- TG 23/1/15

HEATING

System details	Description
Plant Description	Each half of the Energy Centre houses four 4000kW boilers. The boilers provide Medium Temperature Hot Water at 110oC flow and 80oC return. The MTHW is distributed to the plantrooms in the main hospital, where it is stepped down to Low Temperature Hot Water, for Air handling Units, Domestic Hot Water and space heating. The ground floor contains tanks for approximately 1.4 million litres of diesel which is to provide standby fuel for the boilers, should there be a problem with the gas supply and also to provide fuel for the generators, should there be a problem with the grid electricity supply. The gas fired CHP plant is also located on the Ground Floor to provide approx 3000kW of electrical power and 3600kW of heat. Primary heating circuits emanate from the Energy Centre arranged as A and B circuits fed from their respective boiler system. Each of the A and B pipework circuits is sized to provide the full hospital heating requirement. From the hospital header, MTHW radial feeds run via the basement corridors and risers to the hospital's plant areas to serve plate heat exchanger stations and domestic hot water calorifiers. Plate heat exchange units convert MTHW to Low Temperature Hot Water (LTHW) to serve ventilation plant and perimeter heating systems. The purpose of the plate heat exchanger installation is to positively separate the primary MTHW and secondary LTHW circuits to create smaller strategic load centres in a manner which improves system integrity and operational requirements. The units selected provide one unit as complete standby, in the event of planned maintenance or breakdown (e.g. 2 @ 100% or 3 at 50%, etc). From the plate heat exchangers installed within the plantroom areas, the secondary heating circuits systems emanate to serve specific zones of the hospital. Heat emitters are generally ceiling located providing inherent safety in respect of patient care. Where heat emitters are within touch of patients or the public, the emitters shall be of the low surface temperatures type with a mean surface temperature below 43oC. The majority of heating is achieved by either ceiling perimeter radiant panels, active chilled beams or four pipe fan coil units. Air curtains are also provided above entrance doors to alleviate drafts.

Control Strategy	The Building Management System will automatically control the LTHW systems based on temperature demand from AHUs, FCUs and space temperature demands.
Operating Set Points	Primary MTHW Flow Temperature - 105°C Primary MTHW Return Temperature - 75°C Secondary LTHW Flow Temperature - 75°C Secondary LTHW Return Temperature - 60°C Secondary LTHW VT Flow Temperature - 75°C Secondary LTHW VT Return Temperature - 70°C Secondary LTHW VT Chilled Beam Flow Temperature - 60°C Secondary LTHW VT Chilled Beam Return Temperature - 50°C
Safety Features	Frost Protection – refer to BMS for full description Loss of System pressure - Pumps and boilers shutdown Heat detection in plantrooms – Local gas supply and boilers shutdown Emergency Stop Button depressed - Local gas supply and boilers shutdown
Energy Conservation	Energy management carried out by BMS system. F&R setpoints on variable temperature circuits alter dependant on external temperature. Heat Meters have been provided on circuits as detailed in the O&M docs
Maintenance	All the heating plant and equipment should be maintained in accordance with manufacturer's recommendations. A full Preventative Planned Maintenance (PPM) regime can be found within the O&M Information provide on Zutec.

COOLING

System details	Description
Plant Description	Cooling for the new hospital is provided by four 1000kW air cooled chillers located on one half of the Energy Centre roof, with three 1000kW air cooled chillers (plus the condensers for the absorption chiller) on the other half of the roof. Primary Chilled water is distributed to the plantrooms in the hospitals where it is used for chilled beams, fan coil units and air handling units. The department are arranged in a number of zones to suit the control requirements, varying heat gains and use of the spaces. Active chilled beams and fan coil units are also provided for comfort cooling in areas where there is a need for separation or where high heat gains make these a more appropriate choice of systems. The supply air ventilation plant heats or cools the air as required by the control system to provide the correct condition in the various rooms/zones.
Control Strategy	The Building Management System will automatically control the CHW systems based on temperature demand from AHUs, FCUs and space temperature demands. The chillers will automatically operate based on the system demand.
Operating Set Points	Primary Chilled Water Flow Temperature - 6°C Primary Chilled Water Return Temperature - 14°C Secondary Chilled Water Flow Temperature - 8°C Secondary Chilled Water Return Temperature - 13°C Chilled Beam Flow Temperature - 15°C Chilled Beam Return Temperature - 18°C
Safety Features	Frost Protection – refer to BMS for full description External pipework is trace heated Loss of System pressure - Pumps and chillers shutdown

COOLING (cont)

System details	Description
Energy Conservation	Energy management carried out by BMS system. The chillers will operate on a low energy free cooling mode when external temperatures dictate.
Maintenance	All the cooling plant and equipment should be maintained in accordance with manufacturer's recommendations. A full Preventative Planned Maintenance (PPM) regime can be found within the O&M Information provide on Zutec.

VENTILATION

System details	Description
Plant Description	The building is largely sealed with limited openable windows in order to control the internal environment within the spaces and limit the impact of odours from the Scottish Water works adjacent to the site. The Hospital is mechanically ventilated:- ▪ Throughout all internal rooms that have no access to natural ventilation ▪ Perimeter areas where mechanical ventilation is required for clinical reasons ▪ Perimeter areas where mechanical ventilation is required for operational and environmental control reasons. ▪ Deep plan perimeter areas where necessary to assist the natural ventilation The various departments to match their function are served by a number of ventilation air handling systems. In general, each air handling system is served by a packaged air-handling unit containing all components necessary (e.g. fans, coils, filters, etc.) to provide the correct environmental control of those spaces/rooms served. On full fresh air systems, heat recovery devices are provided, to exchange heat between exhausted extract air and incoming fresh air wherever significant energy savings can be achieved. Generally, temperature control is by means of room or duct-mounted sensors which operate, via the automatic control system software the control valves on the hot water and chilled water to the heating and cooling coils respectively. Areas are controlled in zones or as individual rooms as necessary to achieve the conditions required by the ADB Sheets

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Specialist Systems	<u>Isolation Rooms</u> Each lobbied isolation room is provided with its own dedicated ventilation system in line with SHBN 04. Air is transferred to the room via a wall mounted pressure stabiliser and then extracted from the suite via the bedroom and en suite WC, and ducted by fire-clad ductwork to a dedicated extract fan in the plantroom. Each extract fan unit comprises an isolation damper and a centrifugal cased extract fan, with the motor located out of the air stream, where possible ductwork discharges 3.0 metres above roof level. In the Level 2 plantroom serving the Critical Care Ward it is not possible to achieve a safe discharge height of 3.0 metres above roof level. In this case the extract air is HEPA filtered through 'safe change' filter units in the plantroom before being discharged to atmosphere with all other ventilation exhausts.

VENTILATION (cont)

System details	Description
Control Strategy	The general Air Handling Units and extract fans are enabled on a BMS time control schedule with temperature control set points The operating theatre Air Handling Units are operated on demand with the units entering set-back mode when out of use. All AHUs and Special Extract Fans are inverter controlled and have been pre-set during commissioning. The AHU inverters are interfaced with duct mounted static pressure sensors.
Operating Set Points	All inverters and speed controllers have been set at time of commissioning. The supply air temperature set points are variable dependant on the external temperature varying from 15^{O}C to 21^{O}C.
Safety Features	Frost Protection – refer to BMS for full description of software frost protect. The AHUs are also fitted with a manually reset (at unit) frost protection thermostat.
Energy Conservation	Energy management is carried out by BMS system. Supply air set points are variable dependant on external temperature. Thermal wheels and plate heat exchangers have been fitted on the double deck air handling units to recover heat from the extract air being discharged. The units will also make use of free cooling dependant on the external temperatures.
Maintenance	All the heating plant and equipment should be maintained in accordance with manufacturer's recommendations. A full Preventative Planned Maintenance (PPM) regime can be found within the O&M Information provide on Zutec.

1.7 PUBLIC HEALTH SERVICES

FOUL DRAINAGE

System details	Description
Description	Foul drainage is collected from the sanitary fittings, equipment and outlets, by a system of vertical and horizontal pipework distributed within the building, to connect to the in-slab/underground drainage system. The above ground foul drainage system carrying wet discharges, 75mm diameter and above, is installed in cast iron. The above ground foul drainage system 'ventilation and anti-syphon pipework' is installed in uPVC. Fire collars are provided on uPVC pipework above 40mm diameter where passing through fire barriers and in accordance with Building Regulations. <u>Chemical Drainage System</u> A separate ventilated chemical above ground drainage system is be provided for this building, i.e. main waste stacks and anti-siphon ventilation stacks. The system is configured to permit chemical liquid waste materials to pass uninterrupted from the point of collection, i.e. from the appliance/fitting etc, to a point of discharge at ground floor. At this level the chemical above ground drainage system discharges to the below ground drainage system. The above ground chemical drainage system comprises the pipework system from (and including) the joint to the appliance outlet of the sanitary fitment/appliance (specified and installed by others), to (and including) the connection to the above ground chemical drainage system and in-slab/in-ground drainage system. The above ground chemical drainage system is installed in polypropylene or HDPE to best suit the discharge. <u>Above Ground Contaminated (Radioactive) Waste Drainage System</u> A separate dedicated above ground gravity contaminated (Radioactive) drainage system is provided for this building. The radioactive drainage system does not interconnect with the above ground foul drainage or above ground chemical drainage system at any point. Contaminated (Radioactive) drainage is collected by a system of vertical and horizontal pipework distributed within the building, to connect to the in-slab/underground drainage system. The system is configured to permit contaminated (Radioactive) liquid waste materials to pass uninterrupted from the point of collection, i.e. from the appliance/fitting etc, to a point of discharge at ground floor. At this level the

	contaminated (Radioactive) above ground drainage system discharges to the below ground drainage system. The above ground contaminated (Radioactive) drainage system is installed in polypropylene or HDPE to best suit the discharge. All main vertical waste and vent stack pipes and horizontal branch waste pipework installed at low and high level within ceiling voids are jointed using fusion-welded joints. <u>Basement Drainage</u> Separate drainage sump pumps are provided in the basement to handle the discharges from the following areas: Main tank room: Backwash from water filtration plant and water overflow from storage tanks. Fire Tank Room: Overflow discharge from water storage tanks. Basement kitchen and FM accommodation: Sanitary discharges. All pump sets shall be in duplicate and sanitary pump sets shall be ventilated to the above ground foul drainage system. All pumped discharges rise separately and connect to the above ground foul discharge stacks and gravity to drain.
Control Strategy	The drainage sump pumps have their own integral control system with the pumps (twin pumps) operating dependant on the waste level within the chamber.
Safety Features	In the event of a failure or high waste level within the chamber the system will alarm via the BMS
Maintenance	Check drainage traps regularly (especially floor gulley's and equipment condensate traps) and pour water to keep them primed. The drainage system should be maintained in accordance with manufacturer's recommendations. A full Preventative Planned Maintenance (PPM) regime can be found within the O&M Information provide on Zutec.

RAINWATER DRAINAGE

System details	Description
Description	Surface water shall be collected from roof areas including green roofs, by rainwater water outlets connected to a system of vertical and horizontal pipework distributed within the building, to connect to the in-slab/underground surface water drainage system. The system has been configured to permit rainwater to pass uninterrupted from the point of collection at roof level to a point of discharge at ground floor level. At this level the rainwater pipe system discharges to the below ground drainage system. <u>Helipad Drainage</u> A dedicated rainwater pipe serves the helipad, running from the helipad to the below slab drainage connection in the basement. When the helipad is in use, the helipad run-off is diverted to a holding tank on top of the twelfth floor plantroom. This is then discharged via the rainwater pipework and a connection in the basement to the below ground drainage system. All discharge to the below ground drainage from the helipad passes through the petrol interceptor near the A&E entrance. In the event of a fire on the helipad, a foam suppression system is installed for fire fighting purposes. Any foam and debris would then be held in the holding tank and discharged in a controlled manner to the petrol interceptor for disposal via tanker.
Control Strategy	Control of the diverting valves for the helipad drainage system is via motorised 2-port valves which are operated by the staff manning the helipad.
Safety Features	The helipad pipework is installed with pressure rated couplings capable of withstanding the maximum head of water possible in the event of blockage in the system.
Maintenance	Check drainage gulley's regularly to ensure that they are clear The drainage system should be maintained in accordance with manufacturer's recommendations. A full Preventative Planned Maintenance (PPM) regime can be found within the O&M Information provided on Zutec.

WATER SYSTEMS

System details	Description
Plant Description	<u>Domestic Cold Water System</u> Wholesome cold water is derived from 2 No. separate incoming water main supplies entering the basement tank room. Each supply is capable of isolation by valves within the building. A water meter is incorporated on each supply within the tank room with direct reading and a BMS interface From the bulk storage tanks, the wholesome boosted cold-water service is routed via the main distribution routes to roof plant level and vertical risers to

	feed the various departments. In the plantrooms, the wholesome boosted cold water service feeds un-vented HWS plant, and a number of direct connections to demand points within the building, including system pressurisation units, and dedicated water service systems storage tanks, via type AB air gaps for prevention of cross contamination. <u>Hot Water Service installation</u> Domestic Hot Water (DHWS) is generated and stored utilising plate heat exchangers and buffer storage vessels (DHWS plant). The DHWS plant and distribution system is fed and pressurised from the boosted water system. The DHWS plant is directly heated from the main primary MTHW heating circuit from the Energy Centre. The storage temperature is controlled through the BMS by 2-port control valves on the primary heating system. The DHWS plant system is capable of achieving higher storage temperatures for carrying out a pasteurising process to minimise contamination from Legionella bacterium within the storage buffer vessel. Each storage buffer vessel and plate heat exchanger can be isolated from the distribution system while the process is carried out. The DHWS distribution system is configured with a pumped return to maintain temperatures within the system in accordance with SHTM 04-01. The pumped return system minimises “dead legs” and reduces water consumption by providing the correct temperature of water at the outlet with minimum delay. The hot and cold water system pressures is equalised at each service outlet for successful blending of hot and cold water through anti-scalding devices prior to use. The anti scalding devices are installed throughout the hospital where service outlets provide water for personal hygiene washing. Designated outlets supply unmixed hot water at system temperatures where utensils or garment washing is required.
Control Strategy	Each HWS return loop is provided with a thermal balancing valve to ensure the HWS return temperature is maintained at 55^{o}C. The valves provide a thermal balance in the hot water installation by keeping a constant temperature in the system, thus limiting the flow in the circulation pipes to the minimum required level. The water filtration unit and booster sets will operate automatically on water demand. They BMS will pick up a fault signal from the units.

	All water tanks are fitted with high and low level sensors and a temperature sensor that report back to the BMS The hot water temperature at the calorifiers is controlled via the BMS with the circulation pump enabled via time control.

WATER SYSTEMS (cont)

System details	Description
Operating Set Points	Hot water Temperature Setpoint 65^{O}C Thermostatic Valves Setpoint 55^{O}C Wash Hand Basin (TMV) Hot water setpoint 41^{O}C Bath (TMV) Hot water setpoint 44^{O}C Shower (TMV) Hot water setpoint 41^{O}C
Safety Features	Wash hand basin Thermostatic Mixing Valves fitted to wash hand basins to ensure scalding is not possible.
Energy Conservation	WC and urinal cistern water supplies are fitted with presence operated solenoid valves to reduce water wastage in the event of a cistern overflow. Low water content cisterns have been fitted (4.5l and 3l) including dual flush. All taps are fitted with flow restrictors to ensure low water usage
Maintenance	All the Water Services plant and equipment should be maintained in accordance with manufacturer's recommendations. A full Preventative Planned Maintenance (PPM) regime can be found within the O&M Information provided on Zutec.

1.8 ELECTRICAL & CONTROL SYSTEMS

POWER

System details	Description
Plant Description	**LV Distribution** <u>General</u> The Adult and Children's Hospital is provided with 6 pairs of sub-stations, and the Energy Centre with 2 pairs of substations, each sub-station half being fed from the A or B 11kV ring supply, indicated by suffixes A or B respectively on the substation references. The sub-stations in the hospital are located in plant rooms at Levels 2, 3 & 4. Each sub-station comprises 11kV ring main unit switchgear, a step down cast resin transformer and a Main LV switchboard. Each pair of sub-stations is interlinked on the LV side via cables or bus bar and automatic changeover switches, one on each Main LV switchboard fitted with fire barriers at the compartment wall between substation halves. Each pair of Main LV switchboards is electrically interlocked to prevent both transformers being connected in parallel. The Main LV switchboards are referenced as SS1A, SS1B, etc. In the 'Podium' area the main LV switchboards feed sub-main LV switchboards, which are generally located on each floor of each electrical riser. These boards are referenced "SB***". Substations 3 and 4 serve the ward towers from floors 4 upwards via rising bus bars. Substations 7 and 8 serve the Energy Centre. Note that UPS Input Boards are a special case of sub-main switchboards. The requirements are given in UPS description. Generally, unless shown otherwise on the LV schematics, most departments have a minimum of two 3-phase combined lighting and power distribution boards, one distribution board fed from the A side of the LV distribution system and the other fed from the B side. Final circuits throughout the department are split between each distribution board to provide further resilience. A number of departments have a single distribution board provision. The distribution boards are contained within electrical cupboards within each department. <u>Spare Capacity</u>

	The LV distribution network is designed to provide 25% spare capacity in load and spare ways. Sub-Main Cabling Sub-main cabling is generally by XLPE/SWA/LSF multi-core armoured cables laid on cable ladders or slotted cable trays. For life safety and fire fighting applications, cabling is either Prysmian Cables FP Plus or Prysmian Cables FP600S. Metering Electronic multi-function meters connected to the BMS system are provided at the main LV switchboards and elsewhere as detailed on the LV schematics. Distribution Boards Final circuit distribution boards of Type A or B with miniature circuit breakers (MCB) and residual current breakers with overload (RCBO) are located within risers and dedicated cupboards. Certain (designated) loads will be disconnected during generator start-up or load shed operations. **Isolated Power Supplies for Areas of Medical Use** General Isolated power supply units for areas of medical use are provided. These provide Type IT power supplies to meet the requirements of SHTM 06-01, BS.7671 Guidance Note 7 Chapter 9 and MEIGaN guidance published by MHRA. These provide remote alarm facilities in the department served, and serve dedicated distribution boards. The medical locations covered by isolated power supplies are as indicated on the LV schematics and small power circuitry drawings. Transient Overvoltage Surge Suppression Systems Transient overvoltage surge suppression devices aree installed within the main LV switch boards as detailed on the LV schematics. Imaging Department Supplies Power supplies to diagnostic imaging and radiotherapy rooms / suites are compliant with the MEIGaN V2.0 September 2007 document published by MHRA. Supplies to fluoroscopy machines and those imaging machines used for invasive procedures are provided with dual final sub-circuit cables via automatic changeover devices. The steel wire armour of the final sub-circuit cables to fixed imaging equipment is not used as the mains supply earth conductor. Where available, an integral

	circuit protective conductor is incorporated in the final circuit cable to imaging equipment. Where not available a supplementary circuit protective conductor is provided. Illuminated warning signs powered via the contactor are provided at imaging room entrances. <u>Busbar Trunking</u> Generally three-phase bus-bar trunking with full size phase and neutral conductors and plug-in tap-off units is utilised. A reduced earth conductor is provided and the metal casing utilised to provide the required cross sectional area in excess of that required. Distribution of LV power within the tower is by vertical busbar trunking. Each tap off contains a circuit breaker to provide full electronic time graded fault protection. A pair of rising bus-bars (A and B side) serve each of the 'wings' of the tower and are run through the building in separate risers in accordance with the dual-unified distribution method generally employed. Generally, distribution of LV power within the 'podium' and Childrens' hospital plant rooms is by three-phase horizontal bus-bar trunking with dual A and B supplies via auto-changeover contactors. Tap offs are provided to serve the plant room distribution boards and items of plant at centres. Each plant supply tap off circuit breaker status is monitored indirectly by the ENMS. <u>Automatic Power Factor Correction Equipment</u> Power factor correction units are provided for each side of each main LV switchboard, with a hard wired automatic drop out facility to operate during generator run and reset on return to mains. <u>Automatic Transfer Switches for Life Safety Circuits</u> For any circuit supplying fire-fighters' lifts, fire-fighting foam spray systems and sprinkler systems, and for other life safety functions as indicated (e.g. helipad lighting, smoke vents, smoke extract fans, etc.) dual supplies are provided to an automatic transfer switch installed in the same fire compartment as the life safety equipment/plant itself. **Small Power systems** <u>General</u> All areas except where indicated below shall have flush small power installations.

	The exceptions to this are:- Plantrooms, risers, switch cupboards, lift motor rooms, ceiling voids, switchrooms, substations, FM Workshops, Tunnels, UPS rooms and Basement corridors, which have surface installations with metal clad accessories. In SHTM 06-01 Clinical Risk Category 1 and 2 areas, accessories for flush or recessed installations shall have white plastic accessory plates. In SHTM 06-01 Clinical Risk Category 3, 4, and 5 areas, socket outlets shall have metal accessory plates. Socket outlets fed by IPS units are double pole or un-switched, clean earth sockets, with metal front plates, colour-coded blue, engraved in white lettering 'Medical equipment only'. All power circuits serving patient areas are provided with a 30 mA RCD (with Class A characteristics), together with the associated protective MCB at the circuit origin at the distribution board (i.e. an RCBO). <u>Socket Outlets</u> Socket outlets are generally switched 13A, 3-pin to BS 1363. All power circuits are provided with high integrity earthing. Small power circuits wired by means of 4mm2 radial circuits in metal conduits will achieve high integrity earthing as a matter of course without the need for any further special measures. <u>Cleaners Sockets</u> All cleaner sockets are engraved with the legend "CLEANERS USE ONLY" in 4 mm high black uppercase letters. <u>Childproof Socket Outlets</u> In waiting areas or any other area where small children are likely to be present, 13 A socket outlets shall be childproof. This shall be achieved by at least meeting the requirement that the shutters permit the insertion of pins into the socket only if all three pins are simultaneously inserted. <u>Imaging Department Supplies</u> Power supplies to diagnostic imaging and radiotherapy rooms/suites is compliant with the MEIGaN V2.0 September 2007 document published by MHRA. Refer to Small Power Systems for further description. <u>Illuminated warning signs</u> For all X-ray and laser equipped rooms, the X-ray and laser warning signs external

	to each room are provided, interlocked with the fixed equipment such that when the X-ray or laser power supply in a room is energised the 'radiation warning' or 'laser in use' section illuminates, and when the equipment is in operation the "do not enter" section illuminates. Sockets serving portable equipment are provided with additional contacts for illuminated warning signs. <u>Controlled Drugs Cabinet Supplies</u> Any fused connection unit serving a controlled drugs cupboard alarm is installed inside the cabinet so that access to it is possible only when the cupboard is open. These connection units are of the unswitched type. <u>Provisions for Catering</u> Freezer/Cold Rooms: Main Kitchen in Basement and Restaurant Kitchen on 1st Floor: The freezer rooms and cold rooms in the main kitchen in the basement and the restaurant kitchen on the 1st floor are provided with power supplies to their control panels. Power supplies are provided to the freezer/cold room condenser units. Kitchens: Restaurant Kitchen on 1st Floor: Servery units in the first floor restaurant are provided with individual power supplies. Each servery unit incorporates a distribution board provided by the Catering Specialist. First floor and basement kitchen distribution boards are fitted with emergency power off contactor and two shrouded knock off buttons provided in each kitchen. <u>Provisions for Workshops</u> Circuits serving workbenches within workshops are fitted with emergency power off buttons which, on operation, isolate the workbench work station supplies only. <u>Computer Rooms</u> Small power in the two main computer rooms is provided via dedicated UPS systems. **Uninterruptible Power Supplies (UPS)** UPS are provided to serve the loads as follows:- • 2 main IT server rooms • Isolated Power Supplies (IPS) serving theatres

	• IPS serving areas other than theatres Configuration Each server room is served by two independent UPS's in a 2n configuration, one delivering power from the 'A' side of the hospital's dual distribution system, the other from the 'B' side of the hospital's LV distribution, and with outputs synchronized, but not paralleled. Thus, each server room is provided with conditioned power from both 'A' & 'B' sides of the distribution system, with both being distinct all the way to the respective Server Room. Each UPS is expected to be loaded (by connections within the server rooms) to 50% of its capacity, but be capable of supplying the whole 100% in event of failure of the other UPS. Each departmental clinical area is served by a pair of parallel redundant UPS units in an n+1 configuration, each UPS being loaded to 50% of its capacity. For additional resilience the UPS output board is served by a separate supply which can be manually switched. The parallel redundant configuration of the UPS and the feeds to duplicated Isolated Power Supply equipment in the departments maintain resiliency in supplies to the clinical areas. The UPS units, within their pairs, are designated: - in the case of UPS systems for the Server Rooms, as A and B side UPS (where A & B still denote the two sides of the hospital's dual supply distribution system). - in the case of UPS systems using parallel units for the clinical loads, as 1 and 2. Battery/Autonomy Batteries are to selected to provide a design life no less than 10 years. Autonomy times are: Server Room UPS - . for each individual UPS, 15 minutes, giving a total system autonomy of 30 minutes per UPS pair. UPS for Non-Theatre IPS - for each individual parallel redundant UPS, 15 minutes, giving a total system autonomy of 30 minutes per UPS pair. UPS Theatre IPS - for each individual parallel redundant UPS, 30 minutes, giving a total system autonomy of 60 minutes per UPS pair. UPS Switching & Related Control Each UPS includes switches to facilitate the complete isolation of each individual UPS, for testing and maintenance. The UPS are fitted with control & interlock features to safeguard the UPS during all conditions of current sharing whilst in parallel and against incorrectly sequenced operation of static switch and bypass switch. Other Features Each UPS has a remote alarm indicator for the benefit of User Department staff. In all cases, local controls permit silencing of an alarm buzzer and

	selecting/scrolling through the displayed information, but the UPS units cannot be operated in any way from the remote panels. <u>Switchboards</u> For the UPS systems serving the server rooms, switchboards are supplied & installed on the incoming and outgoing side of the UPS combinations. For the UPS systems serving the clinical areas, switchboards are supplied & installed on the outgoing side only of the UPS combinations, input switchboards are not provided. For the clinical areas (theatre and non-theatre), the Output board is located elsewhere as indicated on the drawings. The Output switchboards include an interlocking scheme arranged to prevent damage to the UPS equipment when being switched by an Operator into or out of bypass condition or parallel condition. Note that interlocking is not provided to prevent the load being switched off, it is provided to safeguard the equipment and provide some assurance to the operator that he will be prevented from doing damage to the UPS units whilst permitting him to use bypass conditions and paralleling/breaking parallel to keep the loads energised. The Sub-Contractor may modify these as appropriate for the equipment he offers. <u>"Wrap Around" Bypass</u> Each UPS (whether or not part of a parallel pair) is provided with an external wrap-around maintenance bypass facility which shall render the UPS entirely safe for maintenance and trouble shooting to the extent that a complete UPS unit can be 'swapped out' if necessary. For the Server Room UPS systems, the A and B side UPS unit arel each configured with a "wrap around" maintenance bypass facility. For the clinical area (theatre and non-theatre) UPS systems, each pair of UPS units is configured with a "wrap around" maintenance bypass facility. <u>Operation on System Healthy</u> The load is equally shared between each UPS of a paralleled pair. <u>Operation on Failure of One UPS</u> The total load is transferred to the healthy UPS. In the case of paralleled UPS units, the communication/control link will permit the failed UPS to block its inverter output and the healthy UPS to take over the whole of the load.). In the case of the independent synchronized UPS units for server rooms, failure of one UPS results merely in the operation of that UPS's static bypass, or in

	extreme conditions the operation of the static bypass followed by the blocking of the inverter output (all as necessary to protect the UPS). The UPS configuration serving the server rooms is designed on the basis that computer equipment will be "dual cord". <u>Software</u> Open protocol industry standard software is used.
Control Strategy	An Energy Network Management Systems (ENMS) has been provided which provides information on generators and High Voltage switches. In the event of a High Voltage power failure to the building the HV generators within the energy centre will provide power to the building. The UPS within the building will provide continuous power to essential services during the time between loss of power and the generators taking the load.
Safety Features	Emergency Stop buttons have been provided within the HV transformer rooms that when depressed will shut down the transformer.
Energy Conservation	Energy management carried out by BMS system Electrical consumption meters have been provided for all electrical supplies to Distribution Boards and plant etc. The meter readings can be viewed directly at the appropriate equipment or at the BMS PC.
Maintenance	All the electrical equipment should be maintained in accordance with manufacturer's recommendations. A full Preventative Planned Maintenance (PPM) regime can be found within the O&M Information provide on Zutec.

LIGHTING

System details	Description
Plant Description	Wiring The wiring system is generally be a metal encased prefabricated wiring system. Armoured flexible conduits is laid on wire cable baskets. Through access luminaires which permit services access into the ceiling void through the body of the ~~luminiare~~luminaire are installed in the following areas with Category 1 ceilings (ceiling categories as per the ADB Room Data Sheets):: i) Operating theatres ii) Anaesthetic rooms Theatre Operating Table Luminaires Power supply units for the luminaires are located in the corridor cupboard adjacent to the theatre, as shown on the drawings. The luminaires incorporate a no-break battery backup of 3-hour duration. Daylight Linking In rooms provided with automatic absence detection and which benefit from natural daylight, luminaires near the windows are automatically dimmable, regulated by the amount of daylight available. Manual override of automatic dimming is not provided. This does not apply to departmental corridors or hospital streets. Daylight Control of Bedroom Lighting Bedrooms are not provided with movement detectors, however the luminaires nearest the windows are daylight controlled. An external light sensor is fitted to each face of the ward tower plantrooms facing NSE&W and to each face of the Children's Hospital plantroom also facing NSE&W. The NSE&W facing light sensors control luminaires in NSE&W facing bedrooms respectively. Daylight Control of Atria Lighting The main Atria lighting is daylight linked regulated by the amount of daylight available to achieve the illumination levels stated in the Room Data Sheets. External light sensors are fitted externally to the Atria in appropriate locations. These sensors are independent of those required for the daylight control of bedroom lighting. Dimming in Ward Corridors Automatic lighting control is not provided in ward corridors. Ward corridors are provided with manual switches to permit staff to regulate light output to preset levels of 0%, 25% or 100% in accordance with the Room Data Sheets and LG2. Refer to lighting layouts for switch locations.

	Manual Switching The lighting drawings indicate switching arrangements and nominal locations of lighting switches. Where reading lights for patient use are provided at bedheads they are controlled by a switch at the bedhead and at the patient handset. Manual Dimming Refer to the Room Data Sheets and as-installed drawings for the extent of dimmable rooms. **Emergency Lighting** General Self-contained units are utilised throughout and shall be connected to an addressable emergency lighting test system to reduce the maintenance burden. Addressable Emergency Lighting System The system comprises:- • Central control and reporting computer • Local test panels • Addressable emergency lighting luminaires fitted with test interface • Hand held programmers (1 and spare) • Networking Cabling The central PC for the test system is located in the main control room in the FM department. The test system enables scheduling of testing so that tests are automatically carried out at a convenient time. The system continuously monitors the health of all connected components and provides fault alarms within seconds. Manual Emergency Lighting System Emergency luminaires within tenanted retail units will be tested manually by key switches. These luminaires will not be linked to the central addressable emergency lighting system. The tenant will be responsible for the testing of their own luminaires.
Control Strategy	Automatic Lighting Control A global automatic lighting control system is installed which through the means of automatic controls makes use of available daylight where specified, regulates

	lighting levels, monitors luminaires for lamp failure and permits easy reconfiguration. The automatic lighting control system is run over the KNX BMS system. The following paragraphs explain the automatic lighting control philosophy within various areas, refer also to the lighting control schedule in Appendix B. Absence Detection where Indicated on the Drawings: Manual switching is provided to turn lighting “ON” and “OFF”. In addition, automatic presence detectors shall be provided in these areas for switching “OFF” lighting when areas are unoccupied. Presence detectors shall not switch lighting on. Automatic presence detectors shall be provided with adjustable time delay and shall be set to 10 minutes. In general absence detection is provided in: • Offices • Consulting rooms • Interview rooms, this is not an exhaustive list, refer to the drawings for completeness Presence Detection where Indicated on the Drawings: Automatic presence detectors only shall be provided for switching lighting “ON” when areas are occupied and switching lighting “OFF” when areas are unoccupied. No light switches are provided in these rooms. Automatic presence detectors are provided with adjustable time delay which shall inhibit the extinguishing of luminaires for a predetermined period. The time delay is set to 20 minutes. In general presence detection is provided to: • Bedroom En-Suites • Store rooms • Linen cupboards • Toilets • Bathrooms • Ward kitchens/pantries • Plant rooms (see lighting control matrix) • Services risers/cupboards • Shower rooms • Changing rooms • Departmental corridors and hospital streets (but see below)

	Again, this is not an exhaustive list, refer to the drawings for completeness. <u>Atrium Lighting Control</u> The lighting within the adult's and children's atria is automatically controlled as detailed in the section above. Ceiling mounted automatic presence detectors are located within the occupied areas as below and control the lighting in the detection areas. • Adult's – ground & first floor • Children's – ground floor only The lighting control system within the Atria is configured to permit different lighting 'scenes' as detailed by the lighting designer and agreed with the Board.
Safety Features	Circuit protection provided by RCBO circuit breakers within the distribution boards
Energy Conservation	Energy management carried out by BMS system Refer to controls section above for details
Maintenance	All the lighting equipment should be maintained in accordance with manufacturer's recommendations. A full Preventative Planned Maintenance (PPM) regime can be found within the O&M Information provide on Zutec.

COMMUNICATION / DATA

System details	Description
Plant Description	A Cat 6a data cable infrastructure has been installed within the building from Data cabinets located within the 2no Server Rooms linked to the 2no IT Node rooms to RJ45 data socket outlets located throughout the building. The 2No Server Rooms and IT Node Rooms are linked via resilient 40 core blown fibre optic network cable. The 2no Server Rooms have fibre optic links to the existing Hospital (Node 12) and to the Laboratories (1810190) Energy Centre (Nodes 191&192) Copper telephony cable has been installed from the existing hospital telephony room to the Ground floor Server Room rack. Direct telephone lines have been installed from the Ground floor Server Room to the following: • All IT Node Rooms • Goods, Passenger and Robotics Lifts • Multitone Sentinel rack (L0 Security Room) • Multitone paging System rack • Redcare Alarm Control (L0 Security Room)
Safety Features	None Required
Energy Conservation	Not Applicable
Maintenance	The Communication / Data equipment should be maintained in accordance with manufacturer's recommendations. A full Preventative Planned Maintenance (PPM) regime can be found within the O&M Information provide on Zutec.

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FIRE ALARM & DETECTION

System details	Description
Plant Description	A fire detection and alarm system (BS5839 L1 detection category) has been installed within the building with the main panel located within the L0 Security Room. A mixture of smoke, heat and aspirating detector system are located throughout the building with electronic sounders and Xenon beacons that will activate in the event of fire / smoke detected with alert tones going off in Adjacent Zones. Networked Fire alarm panels are provided in the following locations: • Plantrooms • Electrical Cupboards • 4no Meet & Greets A Fire Alarm graphics package (Win-mag) has been provided within the L0 Security Room and at each meet and greet point. The fire alarm is interfaced with a multitone sentinel unit that will send a signal to the Hillington Contact Centre in the event of a system fault or fire activation. The fire alarm system is also connected to an offsite contact centre via a dual comm monitored line.
Control Strategy	In the event of a fire alarm activation the following actions will take place: • Sounders and Beacons will activate • Hillington Contact Centre alerted (Via Multitone) • Fire & Rescue Service alerted (Via Dual Comm) • Lifts will return to safe floor (L0, L1 or basement) or 2 dependant on lift type. • Ventilation Plant will shut down (with the exception of critical systems such as Cat 3 Suite, Fume Cupboards etc.) • Incoming Gas Valve will close (this is a manually reset valve) • Hold Open Doors will close • Shutters will close • PA will silence • Door Access doors will open • PTS will shut down if fire in zone it passes through • Gas suppression systems input in to show activation
Safety Features	Fire detectors installed throughout the building
Maintenance	The fire Alarm equipment should be tested in accordance with BS5839, Insurers requirements and maintained in accordance with manufacturer's recommendations. A full Preventative Planned Maintenance (PPM) regime can be found within the O&M Information provide on Zutec.

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SECURITY SYSTEMS

Access Control
The design of the access control systems for the doors has been carefully considered in relation to clinical requirements and patient, staff and public safety. This has included in depth review with the NHS who will be responsible for the management and safe running of the healthcare facility.
In areas of the hospital that have less than 60 members of the general public during operating hours; the doors across escape routes will be free swinging or held open and released to a free state on alarm. Where they form part of a secure boundary they will be fitted with electromagnetic locks linked to the fire alarm system to cause them to release to a free state when required for escape, or release on withdrawal of power or system error to BS EN 7273-4: 2007. During normal use these locks will be released on the secure side by way of a green push button located on an adjacent wall in compliance with BS EN 54: Part 11: 2001.

System details	Description
Plant Description	Intruder Alarm An Intruder detection and alarm system has been installed within the building comprising of perimeter detectors and door contacts. The Intruder alarm keypads are located in the following locations: Adults • Security Porters Office ENT -022 (This keypad will control the entire system in the adults.) • Cashiers Office ENT- 032 (this keypad will be grouped, and will allow setting and • Unsetting of the cashiers office) • Dispensary PHA-009 (This keypad will be grouped to control dispensary and pharmacy areas) • Pharmacy THE-030 (This keypad will be grouped to control dispensary and pharmacy) • Computer Room 101 FMA0-011(This Keypad will be grouped to control Computer room) Children's • Security Porters Office OPD-006 (this keypad will control the entire system in the children's) • Computer Room 102 PLT-001 (This Keypad will be grouped to control the Computer room) Access Control Electronic Access control to various doors has been installed throughout the building with access to all secure rooms and areas being restricted to personnel with swipe card access. To gain access to the floors or areas the swipe card should be presented at the door reader with egress via the push buttons. Both will release the magnet locks at the top of the doors. An emergency break glass has been provide at each door that when broken will isolate power to the door magnets.

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	The access control panels are located in various areas throughout the building with the control PCs located within Comms rooms 101, the Security Room and FM Helpdesk on the ground floor. From the PC swipe cards and access rights can be programmed and door security altered. CCTV A closed circuit television system has been installed within the building and externally with a mixture of fixed cameras and Pan, Tilt, Zoom (PTZ). The cameras are connected to a server via the CAT6a data infrastructure and the NHS VLAN network. CCTV controllers are located within the FM Helpdesk and 2 Porters Rooms (external camera view only) with viewing also available at the BMS PC. Disabled Assistance Disabled assistance alarms have been fitted within all disabled toilets throughout the building. They are operated via pull cords which will sound an audible alarm within all local receptions and the main reception. The display panel will provide details of the toilet room number where the alarm has been activated. The alarm can be reset via the reset button within toilet. A refuge alarm and communication system has been installed on each floor level of all escape stairwells. When depressed an audible alarm will operate within the Security Office Control panel where a telephone handset can be lifted to allow two way communication with the person at the stairwell refuge. The control panel will identify the located of the alarm and can be rest when required.

System details	Description
Control Strategy	Intruder Alarm In the event of an intruder alarm activation the internal and external sounders will activate and an offsite monitoring station will be contacted who will in turn contact the police and the Hillington contact centre. Access Control The access control system can be overridden (to unlock all doors) by the key switch located within the main entrance.
Safety Features	A Panic Alarm has been installed at the front reception desk which when operated will signal a sounder/beacon within the L0 FM Helpdesk. The alarm can be reset via the key reset on the panic alarm unit at the reception desk
Maintenance	The security equipment should be and maintained in accordance with manufacturer's recommendations. A full Preventative Planned Maintenance (PPM) regime can be found within the O&M Information provide on Zutec.

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BUILDING MANGEMENT SYSTEM

System details	Description
Plant Description	The computer-based system provides Direct Digital Control (DDC) to control, monitor and provide historic data logs for the relevant equipment and processes. The BMS utilises a network of standalone DDC controllers associated with each equipment/plant system. Controllers communicate using an open communication protocol in accordance with ISO 16484-5 and CEN TC247 at management and automation levels. Use of open protocols also allows the integration of plant manufacturer's bespoke controllers/control strategies where applicable. An additional P.C is provided at the front end for administration and programming. The Graphical User Interface connects to network controllers via the Engineering Network and is covered by the 1hr UPS back up for the Engineering Network server. The BMS front end accesses real time data from the BMS network and allows users to view and edit all BMS values via user friendly colour graphic displays as well as receive alarms and logged data. Network controllers are located in major plantrooms and key riser locations and connect to a field network of DDC controllers associated with each equipment/plant system. Each network node functions as a router and the mesh network has a proactive

	discovery function to constantly search for and remember optimal linkages, providing a diverse routing capability. The DDC controllers also communicate on a 'peer to peer' network level with frequency inverters to allow full bi-directional data transfer to eliminate BMS point duplication and provide more efficient performance, monitoring, alarming and metering. The BMS interface generates escalating alarm screens when plant is run under manual control.
Control Strategy	Refer to Plant description above
Safety Features	The Building Management System will safely operate and control the plant and equipment and will take appropriate action if plant and equipment goes out with safe working parameters

BUILDING MANGEMENT SYSTEM (CONT.)

System details	Description
Energy Conservation	Energy management carried out by BMS system which monitors all mechanical and electrical meters and will give reports detailing the building energy used. Within the occupied spaces the temperature is controlled on an occupancy basis. The temperature set points within space will alter dependent on whether the space is occupied or the season (summer or winter).
Maintenance	The Building Management System and associated equipment should be maintained in accordance with manufacturer's recommendations. A full Preventative Planned Maintenance (PPM) regime can be found within the O&M Information provided on Zutec.

1.9 SPECIALIST BUILDING SERVICES

MEDICAL GASES

System details	Description
Plant Description	The following laboratory gases have been provided within the building: • Oxygen • Nitrous Oxide • Entonox • MA4 • SA7 • Medical Vacuum • AGSS The Oxygen is derived from 2no duplex VIE tanks and thereafter piped up through the floors via a ring main. The Nitrous Oxide is derived from Manifold supply in the external Manifold Room and thereafter piped up through the floors. The Entonxo is derived from Manifold supply in the Manifold Room EMC-095 within Ground Floor Zone A and thereafter piped to the emergency department. The MA4/SA715 derived from 2no separate plant sources, 1 for the Adults Hospital situated in level 3 Plant Room and the other on level 2 Plant Room serving the Children's Hospital. The plants are both combi plants and deliver MA4 and SA7 via reducing stations at each plant. The MA4 and SA7 have emergency Manifold supplies also from the external Manifold Room with pipelines linked and piped throughout the building. The Medical vacuum is split into 3 with a plant dedicated to the children's Hospital positioned in level 2 Plant Room. A second vacuum plant is positioned within level 3 Plant Room and serves the Adults Hospital. The 3rd Plant is positioned within level 12 Plant Room and serves the tower block L11-4. There are 44no AGSS Duplex pumps which are located on levels 2,3 & 4 Plant Rooms and Serve numerous departments.
Control Strategy	Local Alarm panels have been installed either within the AVSU CR at staff/nurse bases. These alert staff to localised faults with the pipelines. Plant Alarm is located within the help desk at the LAB Block Building.
Safety Features	Gas Alarm panels have been located with the laboratories. An Oxygen depletion alarm system has been installed within the Liquid Nitrogen Dewer fill store on L0. In the event of low oxygen levels within the room an alarm will sound and extract fans will energise to remove the nitrogen from the store.
Maintenance	All the MGPS gas pipework and equipment should be maintained in accordance with manufacturer's recommendations. A full Preventative Planned Maintenance (PPM) regime can be found within the O&M Information provide on Zutec.

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COMMS ROOM FIRE SUPPRESSION

System details	Description
Plant Description	A gaseous fire suppression system has been installed within the Basement main Comms room that in the event of a fire within the room will discharge gas to displace the oxygen within the room to extinguish the fire. The gas cylinder is located within the room with the control panel located outside at the door.
Control Strategy	In the event of detection of smoke within the room the system will alarm (and send a signal to the main fire alarm system) and after 30 second release the gas into the room. When the first alarm signals the BMS will switch the local ventilation off and close the control dampers. A gas extract ventilation system has been provided to remove the extinguishing gas from the room. The fan is operated via the control panel
Safety Features	In the event of an alarm sounding when a person is in the room the system can be delayed by pressing the push button at the door. Unless the button is pushed the system will activate in the pre set timescale. Exhaust valves have been fitted at each manifold. When entering the room to carry out any work the key switch on the control panel should be set to manual so that the gas will not discharge when the room is occupied.
Maintenance	The gaseous fire suppression system and equipment should be maintained in accordance with manufacturer's recommendations. A full Preventative Planned Maintenance (PPM) regime can be found within the O&M Information provide on Zutec.

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LIFTS

System Details	Description
Plant Description	***The following lifts and escalators have been installed within the building:*** ***(see attached plans)*** Core A – Public lifts 1 to 3 serving floors 0 to 11 – lift 2 is firefighting Core B – Public lifts 4 to 6 serving floors 0 to 11 – lift 5 is firefighting Core C – Bed lifts 7 to 9 serving floors 0 to 11 Core C – Bed lifts 10 to 12 serving floors -1 to 11 Core C – Housekeeping lifts 13 and 14 serving floors -1 to 11 Core D – Goods lifts 15 and 16 serving floors -1 to 12 Core F – Housekeeping lift 17 serving floors -1 to 3 Core F – Goods lift 18 serving floors -1 to 3 Core G – Helipad lift 19 serving floors -1, 0, 1, 2, 12 & 13 Core G – Goods lift 20 (backup for the helipad lift) serving floors -1, 0, 1, 2, 12 & 13 Core H – Bed lifts 21 and 22 serving floors -1 to 3 Core H – Goods lift 23 serving floors -1 to 4 Core H – Housekeeping lift 24 serving floors -1 to 4 Core J – Public lifts 25 to 28 serving floors 0 to 3 Core K – Bed lifts 29 and 30 serving floors -1 to 4 Core K – Housekeeping lift 31 serving floors -1 to 4 Core K – Goods lift 32 serving floors -1 to 4 Core L – Public lift 33 serving floors 0 to 4

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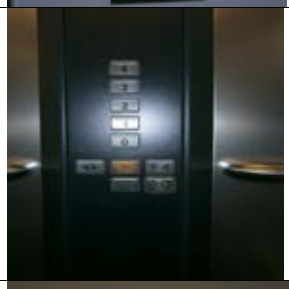
	Core M – Housekeeping lift 34 serving floors -1 & 0 Main entrance - Escalators 1 and 2 serving floors 0 to 1 ***The following lifts can be used by the AGV's:*** Core C – Lifts 13 & 14 Core D – Lifts 15 & 16 Core F – Lifts 17 & 18 Core H – Lifts 23 & 24 Core K – Lifts 31 & 32 All the lifts with the exception of lift 20 are machine room less with the control panel located at the top floor served. Lift 20 has a machine room located above the lift with access from the roof level. The two escalators are self-contained with all drives and controls located within the structure of the escalators.
Control Strategy	All the lifts are connected to a lift monitoring and control system (Schindler Lobby Vision – brochure attached) with the servers being located within the main hospital and the monitoring station located in the Laboratory Building Security Room. Lobby Vision is used by the AGV's to operate the AGV enabled lifts as required. The Public lifts in cores "A", "B" and "J" are fitted with Schindler Miconic 10 Destination Control, this provides passengers with shorter waiting times and quicker journey times. All the Bed lifts are fitted with Schindler Miconic 10 Destination Control to provide shorter waiting times and quicker journey times, Schindler ID is also fitted to give enhanced security and control over the use of the lifts by the use of security cards.

	All the remaining lifts have conventional control systems fitted. The escalators are turned on and off via a key switch located on the inner deck of each escalator at the "0" floor level, emergency stop switches are located at each end of each escalator. Safety pictograms are affixed to the glass balustrade at each end of each escalator.
Safety Features	All the safety features required by BS EN81 have been included within the lift installation. This includes the provision of an alarm system within each lift car that allows two way communication with the 24 hour call centre in the event of persons becoming trapped in a lift. All the safety features required by BS EN115 have been included within the escalator installation.
Maintenance	The lifts and escalators should be maintained in accordance with the manufacturers recommendations and instructions. Full details of the recommended planned maintenance can be found within the O & M information provided on Zutec.
OPERATING THE LIFTS	
Procedure	Description
Standard Operation	To call a lift press the landing button in the direction you wish to travel (Up or Down). When the lift arrives enter the lift and press the button in the car for the floor you wish to go to. The door open and close buttons will operate whilst the lift is at floor level.
Miconic 10 Operation – See attached Chart	On the Miconic 10 keypad on the landing select the floor you wish to travel to (Pressing the "Wheelchair" button before you select your floor will allow more time to enter the lift and leave more space). The display on the keypad will indicate which lift you should use. When the designated lift arrives enter the lift and you will be taken to your selected floor (there are no floor buttons in the lift).

	The door open and close buttons will operate whilst the lift is at floor level.
Schindler ID Operation	The bed lifts are fitted with a Schindler ID card reader below each Miconic 10 keypad, if activated the keypad will not accept calls unless a valid card is presented to the reader first. Once a call is placed the lifts operate as per the Miconic 10 Operation above.
In case of emergency	In an emergency pressing the alarm button for 3 seconds will connect you to the 24 hour call centre. Speak clearly to the operator and follow any instructions you are given. Do not panic. Do not attempt to climb out of the lift until help arrives, you are perfectly safe either stood or sat in the lift. Each lift is fitted with an inductive loop for the hard of hearing – hearing aids should be switched to the "T" position if fitted.

HOW TO OPERATE LIFTS		
Procedure	**Description**	**Photographs**
Standard Operation	A call button (up or down) is located at each floor. Floors can be selected by depressing the appropriate button within the lift car. The doors can be open /closed from within the car by depressing the door open/close button	
In case of Emergency	In the event of the lift stopping and a passenger becomes trapped depress and hold (for 3 seconds) the alarm button, you will then be connected to an emergency operator – speak slowly and clearly and follow the instructions given. The intercom is fitted with an induction loop system for the hard of hearing	
Fire Activation	In the event of a fire alarm activation do not enter a lift If already within the lift car, the lift will alight at Level O or Level 1 (Level O or level -1 within the goods and robotics lifts), leave the lift car and leave the building by the nearest exit.	

Good and Robotics	In addition to the standard operating procedure the goods, robotics and mortuary lifts are fitted with key switch which can be used to park the lift at a desired floor, the lift will then become stationary at the floor until the key position is altered	

Southern General Hospital
PASSENGER LIFT CALL SYSTEM

Schindler

When you see the keypad or touch terminal please do the following:

1. Please push the number of the **floor you wish to go to,** NOTE: Ground Floor = 0

2. …proceed to the lift indicated i.e A, B, C ,D, E or F. Do not enter any other lift other than the one assigned to you. The other lifts are servicing different floors.

3. When the lift comes step in and enjoy the ride. It has already been pre-programmed to go to your floor.

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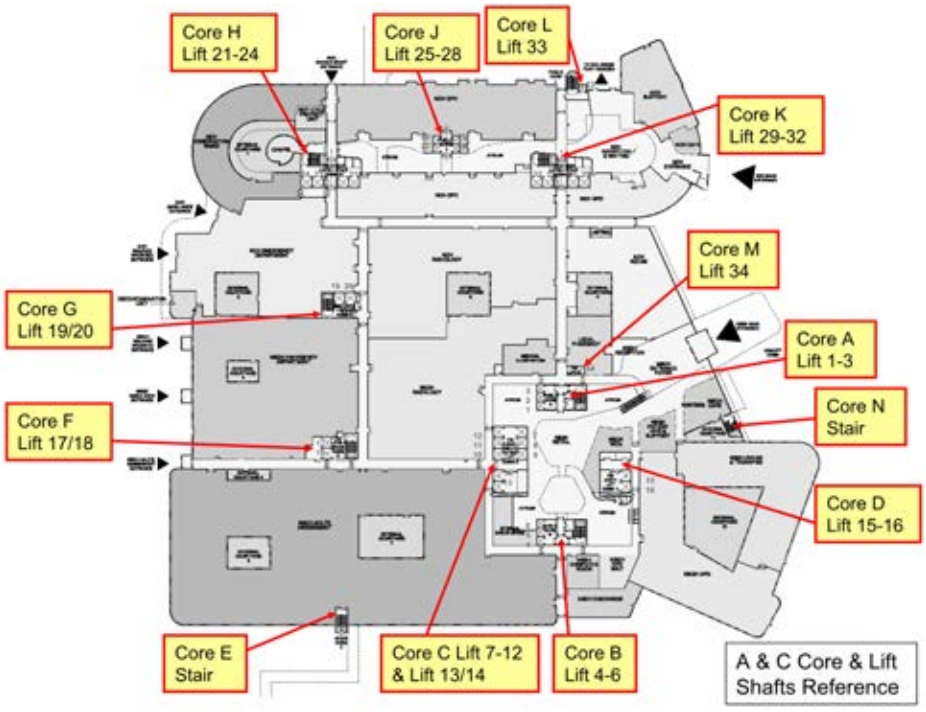
Lift locations and designations

Core.	Lift No.	UNIT No.	Lift Designation.
A	1	10478877	Public
A	2	10478877-1	Public / Firefighting
A	3	10478877-2	Public
B	4	10478877-3	Public
B	5	10478877-4	Public / Firefighting
B	6	10478877-5	Public
C	7	10478877-6	Bed
C	8	10478877-7	Bed
C	9	10478877-8	Bed
C	10	10478877-9	Bed
C	11	10478877-Z	Bed
C	12	10478877-B	Bed
C	13	10478877-C	Housekeeping
C	14	10478877-D	Housekeeping
D	15	10478877-E	Goods
D	16	10478877-F	Goods
F	17	10478877-G	Housekeeping
F	18	10478877-H	4000kg Goods
G	19	10478877-I	Helipad / Firefighting
G	20	10478877-J	Helipad / 4000kg Goods
H	21	10478877-K	Bed
H	22	10478877-L	Bed
H	23	10478877-M	Goods
H	24	10478877-N	Housekeeping
J	25	10478877-O	Public
J	26	10478877-P	Public
J	27	10478877-Q	Public
J	28	10478877-R	Public
K	29	10478877-S	Bed
K	30	10478877-T	Bed
K	31	10478877-U	Housekeeping
K	32	10478877-V	Goods
L	33	10478877-W	Public
M	34	10478877-X	Housekeeping
Main Entrance	1	10478927	Escalator - 1
	2	10478927-1	Escalator - 2

AGV Lift


Core H
Lift 21-24
Core J
Lift 25-28
Core L
Lift 33
Core K
Lift 29-32
Core M
Lift 34
Core G
Lift 19/20
Core A
Lift 1-3
Core F
Lift 17/18
Core N
Stair
Core D
Lift 15-16
Core E
Stair
Core C Lift 7-12
& Lift 13/14
Core B
Lift 4-6
A & C Core & Lift
Shafts Reference

ASEPTIC SUITE ISOLATORS & MICROBIOLOGICAL SAFETY CABINETS

System details	Description
Plant Description	The Pharmacy Aseptic Suite houses 2No isolators for the preparation of cytotoxic products and 6No Class 2 type Safety Cabinets used for the production of antibiotics, steroids etc. Special Extract fans installed in plantroom 41 serve the FC and MSCs.
Control Strategy	The FCs and MSCs are controlled from the local unit mounted controllers. The Special Extract Fans are controlled via the Building Management System and demand from the FCs and MSCs
Operating Setpoints	Refer to Mach-Aire documentation on the O&M file
Safety Features	In the event of a loss of ventilation at the isolators and MBSCs, a local alarm will sound. The user should stop using the unit immediately. The exhaust ducts from the isolators and MBSC's are clearly labelled "Biohazard" and discharge at a safe distance 3 meters above the plantroom roof.
Maintenance	Prior to carrying out any maintenance on the isolators and MBSCs and associated fans and ductwork the laboratory technicians should be contacted to ensure that the equipment has been decontaminated if required. The isolators and Microbiological Safety Cabinets should be maintained in accordance with manufacturer's recommendations. A full Preventative Planned Maintenance (PPM) regime can be found within the O&M Information provide on Zutec.

1.10 MAINTENANCE STRATEGY AND HISTORY

General
A planned preventative maintenance strategy is in place for the SGUH & RHSC Building. The General Maintenance and PPM schedule located on the Zutec database (www.zutec.com) should be followed with all maintenance documented and recorded. Maintenance should only be carried out by suitably qualified persons and specialist systems such as Natural Gas, Boilers, Lifts, ~~Laboratory Gas~~ should only be maintained by Specialist Contractors.

Maintenance Details	2015	2016	2017	2018
Number of Planned Preventative Maintenance Activities Carried Out				
Number of Reactive Maintenance Activities				

1.11 STATUTORY INSPECTIONS

Inspection / Certificate	Issue Date	Expiry date
Legionella Risk Assessment	26/01/2015	26/01/2016
Domestic Water System sterilisation	26/01/2015	26/01/2016
Water Test Log Book	26/01/2015	26/01/2016
Air Conditioning Energy Inspection	26/01/2015	26/01/2016
Fire alarm Testing	26/01/2015	26/01/2016
Fire Appliance Certificates	26/01/2015	26/01/2016
Fire Risk assessment	26/01/2015	26/01/2016
Gaseous Fire Extinguishing system inspection	26/01/2015	26/01/2016
Electrical Inspection & Testing	26/01/2015	26/01/2016
Emergency Lighting testing	26/01/2015	26/01/2016
Lightning Protection Inspection & testing	26/01/2015	26/01/2016
Lifts Installation Examinations	26/01/2015	26/01/2016
Pressure Equipment Directive	26/01/2015	26/01/2016

1.12 WRITTEN SCHEME OF EXAMINATION FOR PRESSURE SYSTEMS

Element	Location of Written Scheme	Renewal date
Not Applicable at Handover		

2 .0 EMERGENCY INFORMATION

2.1 BUILDING CRITICALITY RATING

Room Description	Location	Function	Criticality Rating
Two Main Computer Rooms	FMAO-011 – GF , PLT4-001 – L4	Main Comms Room for the building holding the servers for: Building Management System, Lift Management System, CCTV	High – Important equipment critical to the operation and security of the building
6 main Substations	Sub 1 – Plantroom 41 (L4), Sub 2 – Plantroom 31 (L3), Sub 3 – Plantroom 32 (L3), Sub 4 – Plantroom 33 (L3), Sub 5 – Plantroom 31 (L3), Sub 6 – Plantroom 21 (L2)	HV Distribution Serving the Building	Medium – important electrical distribution critical to operation of the building
Manifold Room	FMB – 006 – Basement	Medical Gas Provision	Medium - important equipment critical to the operation of the building
Water Tank Room	FMB-023 – Basement	Water Supply for the Building	Medium - important Water Storage critical to operation of the building

2.2 LOCATION OF EMERGENCY INFORMATION - Further edit from Darren Pike post-PC

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All emergency information can be found within the Zutec database (www.zutec.com) at the following file path New South Glasgow Hospital / Adult and Children Hospital / Operation & Maintenance Information / Building Services Information / – then as noted below.

Emergency Operating Procedure	Location of Procedure	Date of next review
HV Electrical Power Failure	Electrical / High Voltage / Operation	
LV Electrical Power Failure	Electrical / Low Voltage / Operation	
Fire Alarm	Electrical / Fire Alarm / Operation	
Water Supply failure	Mechanical / Water Services / Operation	
Gas Supply failure	Mechanical / Natural Gas/ Operation	
Water leaks	Mechanical / Water Services / Operation	
Gas Leaks	Mechanical / Natural Gas/ Operation	

2.3 UTILITY ISOLATION

Utility	Detail
High Voltage Electricity	The High Voltage Power can be isolated in the event of an emergency by depressing the emergency Stop Button in the transformer rooms. For non emergency isolation each individual transformer can be isolated by switching the Ring Main Unit **REMEMBER WORK ON THE HIGH VOLTAGE NETWORK SHOULD ONLY BE CARRIED OUT BY AN HV AUTHORISED PERSON (AP)**
Low Voltage Electricity	There are three Main Switchboards serving the building (served from three HV Transformers). To fully isolate the power to the building all three will need to be isolated. Each Switchboard can be isolated by pressing the "off" button at the Main Incoming Air Circuit Breaker. Note that if a Low Voltage Generator is connected into the switchboards then the Incoming Generator Air Circuit Breaker will also need to be isolated by pressing the "off" button.
Incoming Water Supply	There are two separate incoming mains water supplies that enter the building at the basement tunnel near the mortuary. The Hardgate Road Supply is on the left hand side and the Govan Road is on the right hand side. Two isolate the water into the building both blue handled quarter turn valves must be isolated.
Incoming Natural Gas Supply	The natural gas supply enters the building within the Level 1 Pod 3 Plant room. The supply can be isolated by depressing the emergency stop button within the plant room (which will automatically close the solenoid valve) or by closing the hand wheel valve.

2.4 EMERGENCY FIRE FIGHTING

Item	Detail
Dry Riser	There are 5 dry risers located in the building stairwells (one in each stairwell). The inlet breach valves are located on the ground floor externally where the fire and rescue service can connect in, Outlet valves are located on all floors within the stairwells.
Comms Room Gas Suppression	A gaseous fire suppression system is installed within the Basement Comms room. This system will automatically activate in the event of a fire within the Comms Room.
Fire Extinguishers	Hand held fire extinguishers are located throughout the building generally in corridors.

2.5 SPRINKLER SYSTEM

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General
The Hospital is provided with an Automatic Sprinkler System, ordinary Hazard Group III Level protection as described in BS EN 12845. Some areas are not provided with sprinkler protection and these agreed exclusions include the following areas: • Electrical Sub Stations • Server Rooms • IT Hub Rooms A dedicated split water storage tank served by the incoming mains water supply is located in the Basement Tank Room. Duplicate Electric Run/ standby sprinkler pumps are also located in the sprinkler Tank Room and are served from the essential services generator supported electrical supply. A small jockey pump is also installed to maintain static pressure on the system. The sprinkler Zones are each served by Control Valves that are provided with Zone check valves which provide routine checks on the control valves flow switches and give local and central status monitoring. Sprinkler control panel is located in the Ground floor Security Room and is interfaced with the main Fire Alarm panel.

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2.~~6~~5 FIRST AID

Calling for assistance
If you or someone around you requires first aid ~~then, contact the FM Helpdesk on 5555~~ all wards/departments are responsible for having a first aider on duty at all times.
In the event of a serious injury / incident call 999

3 .0 BUILDING UTILITY & ENVIRONMENTAL INFORMATION

3.1 Energy & Environmental Policies

Environmental Rating
The Environmental assessment method used to carry out the building assessment was BREEAM. The BREEAM Scheme was Healthcare 2008

Building Energy Performance

Target Emission Rate	Building Emission Rate
80 $kgCO_2/m^2$	80 $kgCO_2/m^2$

The Building carbon dioxide emission rate has been calculated on the following parameters

Element	Description
Main Heating Fuel	Natural Gas
Building Environment	Air Conditioned
Renewable Energy technology	Energy Centre Combined Heat & Power Unit
Useable Floor Area	171,000m^2
Air permeability	5.0m^3/ (h.m^2)

Energy Performance Certificate (EPC)

Element	Description
EPC Certificate Number	1511-9632-8439-2700-5196
EPC Assessor	Wallace Whittle (London)
Location of Certificate	Main Entrance Reception Desk
EPC rating	B

3.2 Utility Providers

Electricity Provider	**Name**	Scottish Power
	Customer Reference Number	408323346(MPAN- 1800060397688) & 408323346 (MPAN- 1800060397697)
	Contact Details	Lynne Stevenson- [redacted] Group Support Account Manager
	Out of Hours Contact	SP Energy Networks Power Loss & Emergencies 0845 272 7999
Natural Gas Provider	**Name**	Total Gas & Power
	Customer Reference Number	Account Number: to be advised (MPRN 9297852601)
	Contact Details	Su Jolly (National Account Manager) Tel: [redacted] Email: psgas@[redacted] –
	Out of Hours Contact	In the event of leakage/ escape – 0800 111 999
Water Provider	**Name**	Scottish Water
	Customer Reference Number	2521509
	Contact Details	April Beaton Relationship Manager- [redacted]
	Out of Hours Contact	0845 600 8555

3.3 Annual Building Energy Consumption

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Building Energy Consumption						
Design				**Actual (1 year Comparison)**		
Fuel	**Total kWh**	**CO_2 Conversion ($kgCO_2/kWh$)**	**Total kg CO_2**	**Total kWh**	**CO_2 Conversion**	**Total kg CO_2**
Gas	25,532,395	0.194	4,953,389		0.194	
Electricity	34,197,547	0.422	14,431,365*		0.422	

*Also to be deducted is yearly saving from PV, 14,200 kgCO2

Management Monitoring	Photographs
Identifying areas of energy consumption within the building is the first step in understanding where we can improve efficiency and make saving. To aide this electrical, gas, heat and water meters have been fitted within the building to allow monitoring of the energy used. This information is picked up by the Building Management System (BMS) which is used to trend energy use in within the building and its sub departments.	
The main energy consumption (kWh/year) within the building is provided by grid electricity and natural gas.	
Indicative Annual Gas Consumption – 25,532 MWh Indicative Annual Electricity Consumption – 34,197 MWh (Excludes external lighting)	
The building benefits from the Combined Heat & Power (CHP) unit installed within the Energy Centre.	
A Scottish Energy Performance assessment has been carried out on the building with a certified Band B achieved, The energy rating is 28. The Energy Performance Certificate (EPC) is displayed at the building reception.	
The Building Management System Energy manager programme has the capability to compile the metering and energy usage information and produce a report that can be used as part of the overall building energy management strategy.	

3.4 Energy Conservation

Actions that affect Energy Efficiency and Conservation
The building is provided with automatic controls and monitoring to minimize energy use. The temperatures within the offices, bedrooms, theatres and associated clinical spaces are controlled directly from the BMS and have minor tolerance to be controlled locally. Avoid changing the set points on the BMS to suit individual users requirements Avoid blocking radiators or ventilation grilles with furniture and books as this will result in a lack of heating/ventilation. Avoid blocking temperature sensors with furniture Thermostatic radiator valves (TRVs) where installed have been set to the required temperature. Do not use them as ON/OFF switches. If you turn these fully OFF on Friday night then don't expect heat on Monday morning. Do not use local heaters for personal comfort as this can conflict with the zonal comfort controls and result in unnecessary heating or cooling. Unnecessary closure of blinds can prevent the automatic lighting operating correctly. This has been fitted to the lights when natural light levels are high to cut down on the lighting energy used. Do not overheat or over-cool your space as this increases running costs and causes extra emissions of CO_2 into the external atmosphere, contributing to global warming. Only switch the lights ON as and when necessary as they result in significant emissions of CO_2 into the external atmosphere, contributing to global warming. that PCs, printers etc. are not left ON unnecessarily and have any energy saving features enabled as this will prevent your space from overheating and save energy, thereby reducing CO_2 emissions to the external atmosphere that lead to global warming.

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3.5 Energy Monitoring & Recording

Annual Electricity Consumption					
Year	**kWh**	**Kwh/m^2** (kwh/171,000)	**CO_2 Conversion**	**Kg CO_2**	**Kg CO_2/m^2**
2015			0.5246		
2016			0.5246		
2017			0.5246		
2018			0.5246		
2019			0.5246		

Annual Gas Consumption							
Year	**m^3**	**Conversion Factor**	**kWh** (m^3 X CF)	**kWh/m^2** (kwh/22708.027)	**CO_2 Conversion**	**Kg CO_2**	**Kg CO_2/m^2**
2015		11.36			0.1836		
2016		11.36			0.1836		
2017		11.36			0.1836		
2018		11.36			0.1836		
2019		11.36			0.1836		

Annual Water Consumption					
Year	**m^3**	**m^3 / m^2**	**CO_2 Conversion**	**Kg CO_2**	**Kg CO_2/m^2**
2015			0.860		
2016			0.860		
2017			0.860		
2018			0.860		
2019			0.860		

4.0 WATER MANAGEMENT

4.1 Water Strategy – Further text from DP to be inserted post-PC

Water Supply & Management Strategy
Water is supplied to the building from both Hardgate Road and Govan Road (for security of supply) and enters the building at the basement ~~tunnel~~ level.
Both the incoming mains water supplies are metered as they enter the building. ~~A further meter has been provided on the water supply serving the mortuary.~~ All meters are monitored by the BMS
The domestic water to the building (feeding toilets, cleaners sinks, wash hand basins etc.) has been separated from the ~~laboratory supplies (feeding laboratory taps, fume cupboards etc.)~~. Both supplies are fed from different tanks (located in the basement ~~and Office Pod L4 plantroom). The mortuary water supply is served from separate tanks~~ Update paragraph making reference to Break-Tanks and emphasis of system resilience. Insert paragraph on guidance where rooms are out of use for 24hour, also shower usage run free periods and operational usage of Hydrotheraphy pool

Water Saving Features	
All tap outlets within the building have been fitted with flow restricting devices (Require to Check)	
The toilets and urinals have been provided with low water cisterns and the majority of WCs are dual flush. The large button should be depressed for a long flush and small button for a short flush.	
A solenoid valve has been fitted on the supplies to the gents WCs which will automatically open when presence is detected in the room to allow water into the cistern. The valve will then close to stop the water supply (Require to check)	

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4.2 Leak Detection – Further text from DP to be inserted post-PC

Water Leaks - OK
The external and internal meters are monitored by the BMS and will alert if a difference between the meter readings is detected which will indicate that there is an underground water leak which should be investigated.
All Comms Room and the basement water tank room have been fitted with a water leak detection system. Should water on the floor be detected then a local alarm will sound and an alert generated on the BMS.

4.3 Maintenance

Legionella

Legionellosis is the collective name given to the pneumonia-like illness caused by legionella bacteria. This includes the most serious legionnaires' disease, as well as the similar but less serious conditions of Pontiac fever and Lochgoilhead fever. Legionnaires' disease is a potentially fatal form of pneumonia and everyone is susceptible to infection. However, some people are at higher risk, including:

- people over 45 years of age
- smokers and heavy drinkers
- people suffering from chronic respiratory or kidney disease
- anyone with an impaired immune system

The bacterium *Legionella pneumophila* and related bacteria are common in natural water sources such as rivers, lakes and reservoirs, but usually in low numbers. They may also be found in purpose-built water systems such as cooling towers, evaporative condensers and whirlpool spas. There are a number of other risk systems, e.g. humidifiers, air washers, emergency showers, eye wash sprays, indoor ornamental fountains, aqueous tunnel washers etc that could potentially be a source for legionella bacteria growth.

There is a reasonably foreseeable legionella risk if your water system has any of these factors:

- has a water temperature between 20–45 °C,
- creates and/or spreads breathable droplets, e.g. aerosol
- stores and/or re-circulates water
- likely to contain a source of food for the organism, e.g. presence of sludge, scale or fouling

If conditions are favourable, the bacteria may grow increasing the risks of legionnaires' disease. Therefore, it is important to control the risks by introducing measures outlined in the HSE ACoPs L8 Approved Code Of Practice and Guidance Document.

Measures included to Prevent Legionella

- The DHWS plant system is capable of achieving higher storage temperatures for carrying out a pasteurising process to minimise contamination from Legionella bacterium within the storage buffer vessel. Each storage buffer vessel and plate heat exchanger can be isolated from the distribution system while the process is carried out.
- The DHWS distribution system is configured with a pumped return to maintain temperatures within the system in accordance with SHTM 04-01. The pumped return system also minimises "dead legs" and reduces water consumption by providing the correct temperature of water at the outlet with minimum delay.
- Water temperature relief valves are installed to discharge water from the boosted cold water services to limit temperature rise in areas subject to stagnant water conditions due to limited operational hours. These relief valves open on receipt of an over temperature signal of 23°C from the sensor via the BMS, and close on a signal reading of 20°C.

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5.0 MATERIALS AND WASTE MANAGEMENT

5.1 Policy

Philosophy of Service

Waste Management is designed to govern the management and disposal of Waste generated . All operational procedures will be completed in accordance with NHSGG&C Waste Policy. This includes

a. The safe management and disposal of hospital waste
b. The minimisation of hospital waste
c. The reduction of costs associated with the disposal of waste through management monitoring and good practice.

It is the responsibility of all staff within NHS GGC premises to ensure that wastes are entered into the correct disposal stream.

Description of Service / Work Activity

Waste management services will be provided by FM Integrated Services. This will be in the form of suitable waste containers stored within the disposal hold at floor level. These disposal holds will hold segregated containers of clinical and domestic,. The frequency of the exchange of the waste containers will be in accordance to the agreed schedules A full waste cart will be exchanged for an empty.

The site waste compound is located in the Laboratory & FM service yard. Third party contractors will uplift the waste from the waste compound and transport to the point of disposal. The waste containers will be washed in the Laboratory & FM service yard.

Portering services shall:

- Minimise the risk to patients, employees, staff, visitors and the environment.
- Provide a duty of care in its waste management responsibilities including the final disposal consigned to lincensed contractors.
- Comply with statutory standards and requirements, law, codes of practice. Scottish Hospital Technical Note 3, NHS Scotland Published Technical Requirements and related NHSGG&C Waste Disposal Policies.
- Shall promote a clean and tidy impression of the Board and its facilities.
- Ensure required standards are achieved through the use of the right mix of staff and equipment, effective management systems, clear performance targets and appropriate levels of monitoring. Waste collection and storage areas will comply with the requirements described within Appendix A Service Standards Table 2.

The Board will provide all receptacles, storage containers, consumables and equipment for the provision of the service including, but not limited to those items detailed in Appendix A.

Adherence to Board Policies
The Site Facilities Manager will ensure that Board Policies are adhered to by all members of facilities services staff. The ~~Each~~ Facilities department will operate ~~a local~~ policies and procedures ~~manual~~ which will cover all aspects of the tasks undertaken as well as information regarding uniform policy, the reporting of sickness absence, annual leave requests etc.

Hours of operation
Waste will be produced continuously by department throughout the building. Waste uplifts will be scheduled in accordance to their activity

Quality Standards
The Facilities Management Team will carry out regular service monitoring on a planned basis with set performance indicators. These performance indicators are indicated in Table 3.Check table 3

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Relevant Legislation– JOHN GREEN – NHS TO REVIEW & UPDATE
In all areas the Waste Management Service will comply with the following legislation and guidelines as a minimum: a) The Controlled Waste Regulations 1992 b) Special Waste Regulations 1996 (and amendments) c) Environmental Protection Act 1990 d) Environmental (duty of care) Regulations 1991 e) The Health and Safety (consultation with employees) Regulations 1996 f) The Transport of Dangerous Goods (Safety Advisors) Regulation 1999 g) Transport of Dangerous Goods (Safety Advisors) Regulations 1999 h) Carriage of Dangerous Goods and use of Transportable Pressure Receptacle Regulations 2004 i) Scottish Hospital Technical Note No. 3 – Management and Disposal of Clinical Waste 2002 j) The Radioactive Substances Act 1993 k) Safe Disposal of Clinical Waste issued by HSAC (2nd edition) 1999 In addition the following best practice guidance should be applied: a) Scottish Executive Health Department Mel (93)21 b) Health Services Advisory Committee Safe disposal of clinical waste 1999

Waste Training requirements
The Board requires all employees, including Clinical Staff, to * Disposal e of all items of waste safely and appropriately; * Comply at all times with waste disposal procedures and the NHSGG&C Waste Policy; * Report any problems with waste disposal to their line manager; * Attend any training courses provided and deemed necessary to provide staff with instructions on waste handling. Nursing and FM Staff Clinical staff will be responsible for removing waste sacks from bins when full and transferring to appropriate bin in the disposal hold.

Persons responsible
Facilities,Ward and Departmental Managers are responsible for ensuring the Board's Waste Policy is adhered to. All staff are responsible for ensuring that they comply with their Health and Safety duty of care requirements in relation to waste disposal. Facilities Services provision is the responsibility of the Site Facilities Manager

5.2 Service Standards

Waste Type	Minimum Standard
Group A Clinical Waste	• Orange approved plastic bag; • Bags are sealed with a plastic tie closure for clinical waste sacks NOT staples; • Containers and bins are provided with lids that are sealed prior to collection • Replaced when two-thirds full and in any case daily; • Bags and or containers are labelled clearly to indicate their origin, the name of the hospital and department.
Group B Clinical Waste	• BS 7320 approved properly constructed sharps containers; • Containers are stored away from public areas, radiators, direct sunlight; • There is adequate supply of spare containers; • Replaced when "fill to line" reached and in any case weekly; • On replacement containers should be removed, sealed and labelled; • Sharps containers should not be placed inside clinical waste bags; • Damaged containers shall be placed inside larger, secure, rigid containers which are labelled in accordance with HSAC Safe Disposal of Clinical Waste 2nd Edition 1999.
Group D Clinical Waste	• In accordance Special Waste Regulations 1996. NHS Guidance and Board Policy;
Group E Clinical Waste	• In accordance with HSAC Safe Disposal of Clinical Waste 2nd Edition 1999.
Domestic	• Black bags; • Replaced when two-thirds full; • Containers are stored away from public area.
General	• Appropriate protective clothing is worn at all times when handling Waste; • Bag weight limits are observed and not exceeded; • All containers shall be stored out of the sight of Patients and Visitors; • Containers shall be Waste type-specific, labelled accordingly and used only for storage and transportation of that Waste type; • Bags and containers are sealed and labelled with the source of Waste; • Handling Staff are offered immunisation for certain diseases that may be carried in the waste materials e.g. Tetanus, Hepatitis B.

5.3 Building Materials / Components

Cleaning / Maintenance
For full details of how to clean / maintain the materials, equipment and components installed as part of the building then please refer to Maintenance Management PPM within the Zutec database (www.zutec.com). Please see example in box below:

Folder Path:	/ New South Glasgow Hospital / Adult and Children Hospital / Maintenance Management PPM / Maintenance

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Recycling / Disposal
The materials equipment and components used in the building construction and services installations if removed and replaced should recycled or disposed of responsibly. The relevant manufacturers recycling / disposal information should be followed when removing and replacing the items. For full details please refer to the Health & Safety File located within the Zutec database (www.zutec.com). Please see example in box below:

Folder Path:	.. / Adult and Children Hospital / Operation And Maintenance Information / Building Fabric Information / Decoration / 7. Disposal Instructions / 7.1 Disposal of Hazardous Substances

6.0 TRANSPORT & SERVICE YARD

Public Transport
The campus has been designed to allow for greater access to public transport. The new hospitals will now be serviced by a dedicated public transport hub located at the entrance to the Adult and Children's hospitals. The hub includes shelters equipped with Real Time information on scheduled arrivals, and this information will also be displayed in the adult and children's atrium spaces. For the Neuroscience, Maternity, Langlands and WestMARC buildings, public transport will continue to use the existing Langlands Drive, which runs between the Govan Road and Hardgate Road entrances Staff considering public transport can plan their journey by visiting the Strathclyde Passenger Transport website: www.spt.co.uk/journeyplanner. Importantly staff may also be able to save up to 25% of their annual travel transport costs by taking advantage of NHS Greater Glasgow and Clyde's Annual travel ticket loan schemes. Information on the scheme is available via the NHSGGC Travel Plan Office and this can be obtained by emailing travelpo@ggc.scot.nhs.uk. These contact details can also be found on Staffnet. .

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6.1 Parking Bays & Cycle Racks – FURTHER REVIEW REQUIRED TO ENSURE ACCURACY

Description	Quantity	Location
Parking Bays	0	N/A
Disabled Parking Bays	3	Main Entrance
Covered Cycle Racks	66 (33 loops)	Office Pod Covered Area
Mortuary Parking	2	Service Yard
Police Mortuary Parking	2	Mortuary Entrance Area

6.2 Service Yard

Parking

There are three multi-storey car parks on site, however car parking on the campus will be at a premium as the demand for spaces far outweighs availability and will be managed via the Car Parking Policy, the arrangements are designed to balance the needs of staff, patients and visitors, and ensure our car parks continue to be fairly and effectively managed.

The area surrounding the campus will have traffic restrictions and parking controls in place, therefore staff are advised to look at alternative forms of transport. Staff are encouraged to take part in the Liftshare and car share permit schemes that are available. As part of the car park management strategy, a number of spaces will be allocated to car share permit holders. For information on Liftshare and the car share permit scheme contact NHSGGC Travel Plan Office by emailing travelpo@ggc.scot.nhs.uk

NHSGG&C's Travel Plan team provide a range of initiatives that can make it cheaper, easier and more environmentally sustainable for staff to travel to and from their place of work and between sites. For more information on any of these schemes, please follow the link on StaffNet or contact Graeme Condie on [redacted]

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7.0 REFIT AND REARRANGEMENT CONSIDERATION

7.1 Re-fit Building/ Building Sections

General

- Care must be taken when re-positioning tall furniture / cupboards etc, do not obstruct paths for ventilation
- When refitting areas for clinical use, refer to record information to ensure air change rates are appropriate for the intended use.
- Refer to the Major and Minor Equipment Schedules before installing items of equipment which dissipate heat into a space.
- The hospital drainage installation includes more than one type of specialist drainage system and separate rainwater system. Care must be taken not to mix the systems during any future works.
- No air admittance valves are to be installed on any of the drainage systems, particularly the chemical and radioactive systems.
- Flexible hoses are not to be installed on any domestic water systems to prevent the growth of pseudomonas and legionella bacteria.

Environmental consideration is crucial in any future refit. The building has a BREEAM rating and any refit could compromise this rating if not considered properly. The use of natural ventilation, Green Guide A rated materials, reuse of other materials etc, the potential impact of increasing occupancy and any provision made in the original design to accommodate future changes can impact on the BREEAM rating

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Building Services Design Levels	
Element	**Temperature**
External Design Temperature (Winter)	-6 degrees C
External Design Temperature (Summer)	26.2 degrees C DB 18.5 degrees C WB
Secondary LTHW Flow Temp	75°C
Secondary LTHW Return Temp	60°C
MTHW Boiler Flow Temp	105°C
MTHW Boiler Return Temp	75°C
HWS Storage Temp	65°C
Primary Chilled Water operating Pressure	3.0 bar
Primary Chilled Water Flow	6°C
Primary Chilled Water Return	14°C

Secondary Chilled Water Flow	7°C
Secondary Chilled Water Return	13°C
Air Change Rates	Refer to ADB Sheets

Additional Building services
The following must be considered as they will impact upon the sustainable functionality of the building: • The power supply ratings have been agreed during the master planning of the site any increase outwith the design contingency shall require to be agreed with the main infrastructure team. • The heating and hot water loads have been agreed during the master planning of the site any increase outwith the design contingency shall require to be agreed with the main infrastructure team. • Any impact on the site standby generators load scheduling will require to be agreed with the main infrastructure team. • The internal environment is controlled by a BMS systems any modifications will require changes to the controls

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Materials & Waste Management Policies
In the event of any refurbishment, rearrangement, repair or replacement of internal fabric or fittings, full consideration should be given to the policies. (refer to section 3.1 & 5.1)

7.2 Re-arrangement / Addition of Furniture

Furniture & Fittings
The designed layout of furniture and fittings has been made with careful consideration to the building services and building fabric. When considering re-arrangement or addition of furniture the considerations in section 3.1 and 5.1 should be considered and reviewed together with section 7.1

Temporary Furnishings
Any temporary placement of additional items should be carefully considered (as temporary placement has the potential of becoming permanent) as they can have a significant impact on the internal environment.

7.3 Handover Information - Update of dates required

Handover Details	
Date of handover	26th January 2015
End of Defects Liability	26th January 2015
Handover Managed By	Brookfield Multiplex Ltd.
Documents Handed Over	Health & Safety File Operation & Maintenance Manual Planned Preventative Maintenance Schedule (all can be found on the Zutec Database – www.zutec.com)

7.4 Major Changes to Building Services Installation

Date of Work	Description of Alteration	Pages Added / Updated

8.0 REPORTING PROVISION

8.1 Reporting Procedures

Emergency Requirements		
In the event of an emergency situation relating the to the building utilities, please contact the following:		
Utility	**Contact Information**	
Gas	Name:	Scotland Gas Networks
	Telephone:	0800 111 999
Electricity	Name:	Scottish Power
	Telephone:	0845 27 27 999
Water	Name:	Scottish Water
	Telephone:	0845 600 8855

Defect Reporting
In the event of a defect arising within the building and the building services during the two year defect liability period please contact Brookfield Multiplex (details provided in section 8.3)

Maintenance Reporting
All planned and reactive maintenance activities should be formally recorded.

8.2 Building Contacts

Department	Contact Information
FM Helpdesk	5555
IT Heldesk	#650
FM Manager	Name: Ronnie Clinton
	Telephone: [redacted]
	Email: [redacted]
Estates Manager	Name: Jim McFadden
	Telephone: [redacted]
	Email: [redacted]
H&S Officer	Name: John Green
	Telephone: [redacted]
	Email: [redacted]
Fire Officer	Name: Gibby Donnelly
	Telephone: [redacted]
	Email: [redacted]

8.3 Maintenance & Defects Contacts

Department	Contact Information
Brookfield Multiplex	Name: Anthony Fogarty
	Telephone: [redacted]
	Email: [redacted]
Mercury Engineering	Name: Robert O'Donovan
	Telephone: [redacted]
	Email: [redacted]
Fire Alarm Maintenance	Name: TBC
	Telephone:
	Email:
Security Systems Maintenance	Name: TBC
	Telephone:
	Email:
Mechanical Maintenance	Name: Mercury Engineering Ltd
	Telephone: [redacted]
	Email: Robert.o'donovan[redacted]
Electrical Maintenance	Name: Mercury Engineering Ltd
	Telephone: [redacted]
	Email: Robert.o'donovan[redacted]
Lift Maintenance	Name: Schindler Lifts
	Telephone: [redacted]
	Email: N/A

8.4 Building Operating Times

Day	Core Operating Hours
Monday - Friday	**8am – 6pm**
Saturday - Sunday	**Closed**
Mortuary	**24 Hour Operation**

8.5 Health & Safety Issues

Health & Safety Area	Key Points	Location of Full report
Legionella Risk Assessment	As Report	FM Manager
Fire Risk Assessment	As Report	FM Manager
Maintenance Risk assessments	As Report	FM Manager

9.0 TRAINING

9.1 Compulsory Training

Building Services
All new member of FM staff should be given the following training : Mechanical Services Familiarisation Electrical Service Familiarisation Specialist Services familiarisation
FM Maintenance Staff should be given the following training in the building services

System	Area / Type of Training
Barrier System	Car Park
Car Counting System	Car Park
Dry Riser	Car Park
Fire Alarm / Disabled Refuge	Car Park
Lifts	Car Park
Lighting & Power	Car Park
Security Alarm & CCTV	Car Park
Ventilation & Plumbing	Car Park
CCTV	Electrical Training
CHP	Electrical Training
Door Access	Electrical Training
ENMS	Electrical Training
Fire Alarm (& Winmag)	Electrical Training
Fire Alarm Cause & Effect Overview Session	Electrical Training
High Voltage	Electrical Training
HV Generation	Electrical Training
HV Network Disaster Recovery	Electrical Training
Induction Loop	Electrical Training
Intruder Alarm / Panic Alarm	Electrical Training
IPS / UPS Session	Electrical Training
IT / Data Infrastructure	Electrical Training
Lighting	Electrical Training
Lightning Protection	Electrical Training
LV Power	Electrical Training
Nurse Call	Electrical Training
Paging System	Electrical Training
Patient Entertainment	Electrical Training
Public Address	Electrical Training
Wireless network	Electrical Training
Above Ground Drainage	Mechanical Training
Below Ground Drainage	Mechanical Training
Chilled Water	Mechanical Training
Gas Suppression System	Mechanical Training
Medical Gases	Mechanical Training

MTHW & LTHW Heating	Mechanical Training
Natural Gas	Mechanical Training
Sanitary Ware / Macerators	Mechanical Training
Smoke Damper System	Mechanical Training
Sprinklers & Dry Risers	Mechanical Training
Ventilation	Mechanical Training
Water Services	Mechanical Training
Building Maintenance Unit	Other Training
Dental Chairs	Other Training
ETFE Roof	Other Training
Internal Blinds	Other Training
Overdoors / Door Keys	Other Training
Patient Hoist	Other Training
Roller Shutter Doors	Other Training
AGV (Detailed)	Specialist Training
Aseptic Suite	Specialist Training
Catering Main & Basement Kitchen	Specialist Training
Electronic Health & Safety File (including PPM)	Specialist Training
Electronic Wayfinding	Specialist Training
Lifts & Escalators & Control System (Lobby vision)	Specialist Training
Surgeons Panels & Pendants	Specialist Training
AGV (IT/IP)	Specialist System Training
AGV (System Overview & Operation)	Specialist System Training
BMS / Automatic Controls	Specialist System Training
Energy Management Programme ERM	Specialist System Training
Fire Hydrants	Specialist System Training
Helipad Aviation Lighting	Specialist System Training
Helipad Familiarisation & Operation	Specialist System Training
Helipad Fire Fighting equipment	Specialist System Training
Hydrotherapy pool	Specialist System Training
Kitchens / Catering	Specialist System Training
Pneumatic Tube	Specialist System Training
Renal Systems	Specialist System Training

Emergency Training
FM Maintenance staff should be trained in emergency maintenance of the following activities: 1. Water Leaks 2. Gas Leaks 3. Room Overheating 4. Room Under Temperature 5. Ventilation Fan failure 6. Electrical power Failure (Local & Global)

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9.2 Additional Training – Further text from DP to be inserted post-PC

Additional Training	
The following additional training is recommended	
Energy Management	Full training on the energy management aspect of the Building management system
KNX / BACnet Controls	Training in the commissioning and maintenance of KNX and BacNet controls protocol

10.0 LINKS & REFERENCES

For detailed information on the above items please refer to the Building Health & Safety File which contains manufactures literature, the Mechanical & Electrical Operation and maintenance manuals which is provided on the Zutec Database

The following links are useful:

Carbon Trust: www.thecarbontrust.co.uk

The Carbon Trust is a not-for-profit company providing specialist support to help business and the public sector boost business returns by cutting carbon emissions, saving energy and commercialising low carbon technologies.

11.0 GENERAL

This section is not applicable

12.0 -SGUH & RHSC SPECIFIC TRAINING THIS SECTION IS NOT APPLICABLE - INDIVIDUAL DEPARTMENT RESPONSIBILITY FOR TRAINING – ALL GGC STAFF TRAINED TO MANDATORT, STATUTORY AND JOB SPECIFIC REQUIREMENTS

Training
Individual Department responsibility for training – All GGC Staff are trained to mandatory, statutory and job specific requirements -

Further Information
As appropriate FM staff will be advised on how to access the Zutec website (www.zutec.com) where all building system user manuals are held. The FM Manager will advise staff of this as required. :

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CONTRACT MANAGER

New Southern General Hospitals

Project Manager Instruction #4026

Status: Accepted

Notification

Raised By

GGC01.NSGLP.pmoir on 3 Jul 2015 9:42AM

Raised To

BCL01

Response Required By

17 Jul 2015 12:00AM

Title

PMI 424 ADULT HOSPITAL HAEMATO-ONCOLOGY WARD LEVEL 4

Description

Please proceed with the following design works and procurement of materials as follows; Re design of air handling system in Haemato-oncology ward (level 4) leading to the order, purchase and installation of a larger fan motor and associated equipment and works. Procurement of 30 No. new HEPA cartridge filters for the ward, and installation when instructed. Procurement of 2 No. HEPA cartridge filters for the HDU area on Level 1 within CCU Ward, with installation and commissioning when instructed.

Instruction

Please proceed with the following design works and procurement of materials as follows; Re design of air handling system in Haemato-oncology ward (level 4) leading to the order, purchase and installation of a larger fan motor and associated equipment and works. The performance specification to be; • 10-12 air changes hour • Positive pressure differential between single bedrooms and corridor of 5-10 pascals, and between ward corridor and adjacent stairwells and atrium of 2-3 pascals or confirm maximum achievable during design stage. • Propose solution to seal ceilings with current grid arrangement. • Propose pressure monitoring solution for rooms viewable from corridor for each room. Procurement of 30 No. new HEPA cartridge filters for the ward, and installation when instructed. Procurement of 5 No. HEPA cartridge filters for the HDU area on Level 1 within CCU Ward, with installation and commissioning when instructed. Please organise an preliminary meeting with design team and Board to establish scope in more detail. (Note 16th July - HEPA filters for CCW/HDU Level 1 NSGH increased from 2 to 5)

Documents

Document Name

PMI 424- BMCE Quote.pdf

Description

BMCE-PMI 424-QUOTE

File Type

Uploaded

Notes

Title

DIGITAL PRESSURE GAUGES FOR ROOMS

Description

4th August - the Board confirm that Brookfield should develop design and installation based on a digital pressure gauge being provided for each of the 24 single bedrooms, located on the corridor side of the corridor wall adjacent to the doorset to the room.

Submitted

On 4 Aug 2015 by GGC01.NSGLP.pmoir

Sypro Contract Manager

New Southern General Hospitals

Project Manager Instruction #4174

Status: Accepted

Notification

Raised By

GGC01.NSGLP.pmoir on 27 Jul 2015 10:22AM

Raised To

BCL01

Response Required By

10 Aug 2015 12:00AM

Title

PMI 430 QEUH HAEMATO ONCOLOGY WARD LEVEL 4 - 24 SINGLE ROOMS PRESSURE GAUGES

Description

Please establish feasibility of installing digital room pressure gauges in 24No single bedrooms as part of the current adaptations to ward. Gauges to be sourced and installed within current agreed timescale to complete the works. If these gauges cannot be procured then supply and install magnahelic gauges as previously proposed.

Instruction

Please establish feasibility of installing digital room pressure gauges in 24No single bedrooms as part of the current adaptations to ward. Gauges to be sourced and installed within current agreed timescale to complete the works. If these gauges cannot be procured then supply and install magnahelic gauges as previously proposed. Digital gauges to be provided with alarm that sounds once room pressure drops below 5 pascals for 5 minutes, alarm can sound at room or at a central location.

Documents

Document Name

PMI 430- BMCE Quote.pdf

Description

BMCE-PMI-430-QUOTE

File Type

application/pdf

Uploaded

On 18 Aug 2015 by BCL01.NSGLP.leighj

Document Name

VCP PMI 430.pdf

Description

MERC-VCP-PMI 430-Quote

File Type

application/pdf

Uploaded

On 18 Aug 2015 by BCL01.NSGLP.leighj

New Southern General Hospitals

Project Manager Instruction #5453

Status: Open

Notification

Raised By

GGC01.NSGLP.sfrew on 9 Mar 2016 11:20AM

Raised To

BCL01

Response Required By

23 Mar 2016 12:00AM

Title

PMI 471 ADULT HOSPITAL - WARD 4B/HAEMATO-ONCOLOGY WARD - ALTERATION TO BOARD REQUIREMENTS

Description

The Board requests that BMCL establish the feasibility, estimated costs and programme of works in order to achieve the revised specification as listed below Corridor to be HEPA filtered Bathrooms to be fully sealed Room pressures to be 2.5 -8 PA ACH 6/hr Air Change in prep room 6/hr Entrance to ward to be air locked using double door at front entrance. Exit door (beside room 76) to be sealed and only used as fire exit. BMCL is also requested to confirm the timescale to complete the feasibility study.

Instruction

As above

New Southern General Hospitals

Project Manager Instruction #5566

Status: Overdue

Notification

Raised By

GGC01.NSGLP.sfrew on 4 Apr 2016 4:54PM

Raised To

BCL01

Response Required By

18 Apr 2016 12:00AM

Title

PMI 475 ADULT HOSPITAL - WARD 4B/HAEMATO-ONCOLOGY WARD - ALTERATION TO BOARD REQUIREMENTS

Description

The Board confirm acceptance of the design fees as identified for PMI 475 and request that BMCL progress PMI 471 (i.e. establish the feasibility, estimated costs and programme of works to achieve the revised spec as agreed by DWL)

Instruction

As above

Bundle of documents for Oral hearings commencing from 19 August 2024 in relation to the Queen Elizabeth University Hospital and the Royal Hospital for Children, Glasgow

Bundle 16 - Ventilation PPP

A47851278