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 26 – Provisional Position Papers

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SCOTTISH HOSPITALS INQUIRY

Provisional Position Paper 11

Potentially Deficient Features of the water system of the QEUH/RHC

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1. Purpose of the Paper

1.1. This Provisional Position Paper ("PPP") has been produced to assist the Chair in addressing the terms of reference in respect of the built environment of the Queen Elizabeth University Hospital/Royal Hospital for Children (QEUH/RHC), Glasgow, as it relates to the water system (including drainage).

1.2. On 13 December 2023 the Chair issued Direction 5 and indicated his intention that the Inquiry should answer four Key Questions by leading evidence at the Glasgow III hearing due to commence on 19 August 2024 so that those Key Questions can be answered using that evidence along with the evidence from the hearing in the autumn of 2021 ("Glasgow I"); the hearing in the summer of 2023 ("Glasgow II"); all relevant Provisional Position Papers; and the evidence led in respect of ventilation principles and practice at hearings of the Inquiry in respect of Royal Hospital for Children and Young People/Department of Clinical Neurosciences.

1.3. As explained in Part A of Direction 5, this necessarily involves two important stages in respect of the water system (including drainage). Firstly, it is necessary to understand what features of the water systems (including drainage) require to be considered by the Inquiry and secondly to determine the extent to which any such feature is or was in an unsafe condition, in the sense that that feature presented an additional risk of avoidable infection to patients.

1.4. The Inquiry is aware that within the construction contract between Greater Glasgow Health Board ("GGC") and Multiplex Construction Europe Limited ("the Contract"), the word "Defect" is a defined term. The definition of a Defect in the Contract is different from the concept that is addressed in the Key Questions. It should be noted that a separate PPP will be produced later in the first half of 2024 which will analyse the Contract to the extent that it is necessary to answer the Inquiry's Terms of Reference.

1.5. To ensure clarity at the first stage of this process the Inquiry will need to decide whether any particular feature of the water system of the hospital is or was unsafe in the sense that the feature presented an additional risk of avoidable infection to patients and as such can be identified as a "Potentially Deficient Feature". It is those Potentially Deficient Features that the Inquiry will consider.

1.6. This PPP sets out the Inquiry teams' understanding of the water system in place at the hospitals in the period following handover in the first part of 2015, and in particular to set out the Inquiry Team's understanding of the history of the raising of concerns with various aspects of that system. Chapters 5 to 23 of this PPP contain an identification of those Potentially Deficient Features. As is discussed in more detail in Chapter 24 it may be that it is the aggregation of

the effect of a number of these potentially deficient features that places the water system (including drainage) in an unsafe condition, in the sense that that it presented or presents an additional risk of avoidable infection to patients.

1.7. The question of whether those Potentially Deficient Features were in an unsafe condition, in the sense that that feature presented an additional risk of avoidable infection to patients will require to be determined only after evidence has been led and submissions received in the Glasgow III hearing.

1.8. To that end, the main body of this Note is formed of a series of sections corresponding to elements of the water system in respect of which one or more concerns were raised in reports, audits, meetings, etc., and sets out the Inquiry team's understanding of actions taken in response. The intention is for the Inquiry team to be able to articulate in this Note a comprehensive view of the potentially deficient features of the water system.

Procedure to be adopted

1.9. The Chair is likely to be invited by the Inquiry team to make findings in fact based on the content of this PPP. Any core participant or any other person holding relevant information is invited to seek to correct and/or contradict any material statement of fact which it considers to be incorrect and to point to what evidence exists to support the position taken by the core participant or other person. It follows that the Inquiry's understanding of matters set out in this note may change and so this paper is provisional.

1.10. As explained in Direction 5, in order to focus the Glasgow III hearing on features that require to be considered in order to answer the Key Questions, Core Participants are invited to respond to this PPP within three weeks of its publication on the Inquiry website and to direct themselves to answer four questions:

[1] Whether the description of the water system (including drainage) contained within the PPP is accepted as being correct and if there are points in respect of which the Core Participant challenges the description of the system, specifically what the points of disagreement are and what evidence exists to support the position taken by the CP;

[2] Whether the description of any Potentially Deficient Feature is accurate notwithstanding that the Core Participant may not accept that the feature described is potentially deficient or deficient in any sense;

[3] Where the PPP describes the date or dates upon which a Potentially Deficient Feature became known to a particular person or organisation whether the Core Participant accepts that date of knowledge or offers an

alternative date notwithstanding that the Core Participant may not accept that the feature described is potentially deficient or deficient in any sense; and

[4] Whether there are any other features of the water system (including drainage) which should be considered by the Inquiry to be Potentially Deficient Features and what evidence exists to support that conclusion.

1.11. Subsequent Inquiry hearings may touch on some of the matters to a varying extent contained within this PPP but they may not; if parties wish to address the issues dealt within in this PPP then they are invited to do so now. In the absence of a response on a matter, the Chair is likely to be invited by the Inquiry team to make findings in fact based on the content of this PPP.

1.12. Please be aware that all responses to this PPP received by the Inquiry will be published on its website as soon as possible after the deadline for responses has passed.

2. An overview of the water system

2.1. The water system at the QEUH site was designed to enable the circulation of water within QEUH and RHC, from the input at the public water mains to the output at the [public sewer].

2.2. **Input: public water mains.** The fundamental requirement for a system such as that in place at QEUH is that the supply be of 'wholesome water'. This is a legislative requirement which requires that the water supplied be fit for use for drinking, cooking, food preparation and washing, without risk to human health. This does not require that it be sterile – the public supply is expected to contain microorganisms to some extent, without posing a risk to health.

2.3. Scottish Water are the suppliers of the wholesome water at QEUH. The supply is drawn from two input mains at the boundary of the site, one at Hardgate Road and one at Govan Road.

2.4. **Initial storage: raw water.** The water drawn from the public water mains is stored in two raw water storage tanks, each of 100,000 litres in capacity.

2.5. **Secondary storage: filtered water.** In order to provide an enhanced degree of cleanliness, the raw water is filtered before being put to use inside QEUH. There are two stages to this process – firstly it passes through a filtration plant; and once this is done it is stored within a filtered water storage tank.

2.6. Filtration plant. There are two ultrafiltration plants, which take water from the raw water storage tanks and pass it through filters with very small pores. This means that solid matter, including organic matter, above a certain size will be removed from the water supply.

2.7. Filtered water storage tanks. There are two tanks in which the filtered water is stored. These are larger than the raw water storage tanks, at 275,000 litres in capacity. The hot and cold domestic water systems within QEUH are both drawn from these filtered water storage tanks. They are configured into compartments, in order to enable work to be carried out without disrupting the supply of water within the QEUH systems entirely.

2.8. Filters were also present in other areas within the water system, such as where thought appropriate in individual taps.

2.9. **Booster pumps.** The filtered water is moved from storage into circulation by means of two sets of booster pumps. The pumps operate by raising the pressure of the system to an appropriate level to secure an even water flow to each point where it is required. The pressure varies according to location.

2.10. **Hot and cold systems.** There are separate hot and cold water systems. Water is directed by the booster pumps to separate plant rooms for the cold or hot systems.

2.11. The hot and cold systems have separate pipes which are grouped together in the ceiling voids, with valves present on the hot water system to allow maintenance, and also to regulate flow so as to help maintain a consistent temperature.

2.12. The requirements for the project were for pipework to be in stainless steel. The Inquiry is aware that copper piping was also used.

2.13. **Cold water system.** The cold water system was designed to operate as a one-way system, such that water leaving a plant room and moving towards an outlet would not return to the plant room.

2.14. The proper operation of the system would see the integrity of the cold water supply maintained by regular flushing, either: by continual flow-through of water because the outlets at the 'end of the line', such as taps, showers, toilets, etc., were used regularly; or by dump valves triggered at a certain temperature, which thereby opened automatically to provoke flow, thereby flushing the system in that way. In other words, a key feature was that the normal operation of the system should remove the possibility of there being unused sections of pipe where water could collect for a prolonged period and risk becoming stagnant.

2.15. **Hot water system.** The hot water system was designed to operate on a pipe system entirely separate from that for the cold water system. It is not a one-way system, but operates via calorifiers, which consist of plate heat exchangers, used to heat indirectly water which is within buffer storage vessels. From there water circulates through hot water pipes, operated by pumps, so that there is a constant supply of hot water throughout the system.

2.16. The hot water system relied upon an Energy Centre, divided into two separate compartments to ensure continued independent operation.

2.17. Expansion vessels are used to stabilise the hot water system. As the hot water expands and contracts, the pressure in the system may alter. Including expansion vessels in the hot water system provides variable capacity so that the pressure can remain stable. The expansion vessels are formed of tanks which contain a rubber bladder full of air; when the water expands the extra pressure causes the bladder to contract, so that the system overall gains additional capacity.

2.18. **Outlets.** These are the taps, showers, toilets, bathing equipment and any other outlets by which water is drawn for use from the water system. The design of QEUH with single-occupancy rooms resulted in an increased number of outlets compared with older hospitals of similar capacity.

2.19. Taps. May be of complicated design. Certain features within taps may contribute to a higher risk of contamination, such as the roughness of its interior surface, or the presence of devices to regulate water flow.

2.20. Basins and sinks. Physical features of the design, such as shelving, may contribute to a risk of contamination. The drains may also be a site of contamination. A particular risk in a design comes from susceptibility to splashing, which may distribute water over a wider area than the basin or sink in question.

2.21. Showers. These are complicated pieces of equipment, of which certain features may create sites of risk. Valves, hoses and the shower head are examples of this. They may also be used less frequently than other equipment, creating a risk that water trapped within such equipment might grow stagnant.

2.22. **Flexible hoses.** Flexible hoses were specified as not to be used in QEUH, but the Inquiry is aware that some were installed. They are typically used in the connection of fixed pipework to a peripheral outlet or equipment, such as a shower unit. They may pose a risk as the lining used in them, necessary to accommodate flexibility, may be of a type as to be susceptible of contamination.

2.23. **Peripheral equipment.** Various items with specific purposes were plumbed into the water system at QEUH. Dishwashers were installed and connected with flexible hoses. Water coolers were installed as integrated parts of the water system. Other water coolers operated as standalone units and were not integrated into the water system.

2.24. **Monitoring.** A Building Management System network was installed, comprising various components linked to allow for the monitoring of plant,

energy consumption, temperature, etc.

2.25. Meters were also integrated into the system to monitor cold water consumption and other usage in specific units.

2.26. **Waste system.** Waste from basins, sinks and toilets flows by gravity through PVC piping. Each point of entry to the waste system are through a water trap (e.g. a u-bend) to prevent foul air from entering the system. The waste system allows for venting to remove foul odours from the waste system. Discharge is ultimately to an underground foul waste system, and from there to a public sewer at Govan Road.

2.27. **Regulation and Guidance.** As waterborne healthcare associated infections are considered to be preventable, the design, maintenance and operation of hot and cold water supply, storage and distribution systems in healthcare premises is subject to detailed regulation and guidance including that contained in Scottish Health Technical Memorandum 04-01 parts A to G, issued by Health Facilities Scotland; Legionnaires' disease, the control of legionella bacteria in water systems, Approved Code of Practice and guidance on regulations, L8, issued by the Health and Safety Executive (HSE); and HSG274, Legionnaires' disease Part 2: The control of legionella bacteria in hot and cold water systems, also issued by HSE.

2.28. In terms of that guidance, Management (defined as 'the owner, occupier, employer, general manager, chief executive or other person who is ultimately accountable') has the overall responsibility for the implementation of procedures to ensure that safe, reliable hot and cold water supply, storage and distribution systems operate within an organisation. It is responsible for the provision of a wholesome water supply in the relevant premises under its authority, such as a hospital. As is explained in SHTM 04-01 part B para 2.1, all premises are required to have a Legionella risk assessment and a written scheme for controlling any identified risks in accordance with the Health and Safety Executive's Approved Code of Practice L8 (SHTM 04-01 part B para 5.1). Management is required to appoint, amongst others, a 'Designated Person'; an 'Authorising Engineer' to provide an annual audit to the Designated Person; and a 'Legionella Risk Assessor' to provide a Legionella Risk Assessment which should be reviewed on an annual basis. It is provided that a 'Water Safety Group' commission and develop a 'Water Safety Plan' including a risk assessment which should be reviewed on an annual basis (SHTM 04-01 part B para 5.28).

3. Glossary

Acronym/ Abbreviation	Definition
AICC	Acute Infection Control Committee
ARU	Acute Receiving Unit
AP	Authorised Person
BEMS	Building Energy Management System
BMS	Building Management System
BMT	Bone Marrow Transplant
CaFM	Computer Aided Facilities Management
CBUs	Chilled Beam Units
CHP	Combined Heat and Power
CHWB	Clinical Hand Wash Basins
CLO_2	Chlorine Dioxide
CWST	Cold Water Storage Tank
DMA	DMA Water Treatment Ltd
DHCW	Domestic Hot and Cold Water
DHW	Domestic Hot Water
DHWS	Domestic Hot Water System
EPDM	Ethylene Propylene Diene Monomer
F&E	Facilities and Estates
FMFirst	Facilities Management Software
GGHB	Greater Glasgow Health Board
GNB	Gram-Negative Bacteria
HAI	Healthcare Associated Infection
HFS	Health Facilities Scotland
HPS	Health Protection Scotland
HPV	Hydrogen Peroxide Vapour
ICD	Infection Control Doctor
ICE	Imaging Centre of Excellence
IMT	Incident Management Team
IPCT	Infection Prevention Control Team
IPS	Integrated Plumbing System
LP1	Legionella pneumophila serogroup 1
LTHW	Low Temperature Hot Water
LUO	Little Used Outlet
MPX	Multiplex Construction Europe Limited
MTHW	Medium Temperature Hot Water
NEC	New Engineering Contract
GGC	NHS Glasgow and Greater Clyde
OPD	Out Patient Department
PAG	Problem Assessment Group

PALL	Pall Corporation
PB	Polybutylene
PE-X	Cross-linked Polyethylene
PICU	Paediatric Intensive Care Unit
POU	Point of Use
POUF	Point of Use Filter
PPVL	Positive Pressure Ventilation Lobby
Ps	Pseudomonas spp
PsA	Pseudomonas aeruginosa
PVC-C	Chlorinated Polyvinyl Chloride
QEUH	Queen Elizabeth University Hospital
RHC	Royal Hospital for Children
SABs	Staphylococcus aureus bacteremia
SBAR	Situation, Background, Assessment, Recommendation
SGH	South Glasgow Hospital
SHTM	Scottish Health Technical Memorandum
spp	species (plural)
TMT	Thermostatic Mixing Tap
TMV	Thermostatic Mixing Valve
TVC	Total Viable Count
USS	Ultrasound Scan
WHBs	Wash Hand Basins
WRAS	Water Regulations Advisory Scheme
WSG	Water Safety Group

4. List of sources

4.1. The sources used by the Inquiry team have been arranged in chronological order within each of the sections noted below. Where a source exists in an evidence bundle already issued by the Inquiry, this is reflected in the reference of the source.

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GGC documents

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- A41890723 – 23.08.2019 IMT Gram Negative Blood Ward 6A – Bundle of documents for the Oral hearing commencing on 12 June 2023 in relation to the Queen Elizabeth University Hospital and the Royal Hospital for Children, Glasgow – Bundle 1 – Incident Management Team Meeting Minutes (IMT Minutes) – Page 348.
- A38675852 – Minutes – NHSGGC Board Water Safety Group Meeting – 3rd September 2019 – Bundle of documents in respect of the Water Safety Group in relation to the Glasgow 3 Hearings – Page 112.
- A36591627 – 13.09.2019 IMT Gram Negative Blood Ward 6A – Bundle of documents for the Oral hearing commencing on 12 June 2023 in relation to the Queen Elizabeth University Hospital and the Royal Hospital for Children, Glasgow – Bundle 1 – Incident Management Team Meeting Minutes (IMT Minutes) – Page 360.
- A37854452 - NHS Greater Glasgow and Clyde, 'Briefing paper: Ward 6a (Haematology/Oncology)', 16 September 2019 – Bundle of documents in relation to Water PPP – Page 898.
- A38662166 - Briefing for other patients and parents regarding cleaning and sink drains in wards 2A and 2B dated 18 September 2018 – Bundle of Documents for the Oral Hearing Commencing 12 June 2023 – Bundle 5 – Communications Documents - Page 150.
- A37854558 - NHS Greater Glasgow and Clyde, SBAR in relation to Ward 6a, 2 October 2019 – Bundle of documents in relation to Water PPP – Page 904.
- A39123887 – Media Statement titled "NHS GREATER GLASGOW AND CLYDE STATEMENT" by NHS Greater Glasgow and Clyde Health Board dated 4 December 2019 – Bundle of Documents for the Oral Hearing Commencing 12 June 2023 – Bundle 5 – Communications Documents – Page 410.
- A38668814 – Minutes - Water Review Meeting (Technical) - 17 April 2020 – Bundle of documents in respect of the Water Technical Group / Water Review Group Minutes in relation to the Glasgow 3 Hearings - Page 192.
- A38668807 – Minutes – Water Technical Group Meeting - 03 July 2020 – Bundle of documents in respect of the Water Technical Group / Water Review Group Minutes in relation to the Glasgow 3 Hearings - Page 195.
- A38668806 - Minutes – Water Technical Group Meeting - 18 September 2020 – Bundle of documents in respect of the Water Technical Group / Water Review Group Minutes in relation to the Glasgow 3 Hearings - Page 198.

- A32700430 - NHS Greater Glasgow & Clyde Acute Infection Control Committee paper 30 September 2020 – Bundle of documents in relation to Water PPP – Page 909.
- A32700431 - NHS Greater Glasgow & Clyde Acute Infection Control Committee paper, 8 December 2020 – Bundle of documents in relation to Water PPP – Page 919.
- A33448013 – Oversight Board Infection Timeline (Timeline of Incidents for the period 2015 to 2019) - Bundle of documents for the Oral hearing commencing on 12 June 2023 – Bundle 6 – Miscellaneous documents – Page 922
- A40543960 - NHS Greater Glasgow and Clyde, Response to RFI No 8: Filtration Processes – Bundle of documents in relation to Water PPP – Page 929.
- A44311391 - NHS Greater Glasgow and Clyde, Part 1(i) of response to s.21 Notice number 8 – Bundle of documents in relation to Water PPP – Page 945.
- A44311388 - NHS Greater Glasgow & Clyde, Part 1(ii) of response to s.21 Notice number 8 – Bundle of documents in relation to Water PPP – Page 967.
- A44311369 - NHS Greater Glasgow & Clyde, Parts 1(iii), 1(iv) & 2(i) of response to s.21 Notice number 8 – Bundle of documents in relation to Water PPP – Page 978.
- A44311444 - NHS Greater Glasgow & Clyde, Parts 2(i), (ii) and (iii) of response to s.21 Notice number 8 – Bundle of documents in relation to Water PPP – Page 988.

External documents

- A44976432 - Mercury, ‘Domestic Water Service Survey’, undated – Bundle of documents in relation to Water PPP – Page 999.
- A44674683 - Multiplex Construction Europe Limited, ‘Description of the Above Ground Drainage’, undated – Bundle of documents in relation to Water PPP – Page 1000.
- A44312597 - Nicholson Plastics Ltd, Tank Report/Investigation, undated – Bundle of documents in relation to Water PPP – Page 1003.
- A44313070 - Water & Pipeline Services Ltd, Scottish Water Byelaw rectification report, undated – Bundle of documents in relation to Water PPP – Page 1017.
- A33818735 - Capita Symonds, ‘NEC 3 Supervisor’s Report No. 10’, March 2011 – Bundle of documents in relation to Water PPP – Page 1021.
- A44312871 - Capita Symonds, ‘NEC 3 Supervisor’s Report No. 30’, September 2013 – Bundle of documents in relation to Water PPP – Page 1048.
- A44312885 - Capita, ‘NEC 3 Supervisor’s Report No. 36’, April 2014 – Bundle of documents in relation to Water PPP – Page 1091.

- A34316123 - TUV SUD/Wallace Whittle, ‘New South Glasgow Hospitals Specification CHP Systems’, September 2014 – Bundle of documents in relation to Water PPP – Page 1126.
- A35823695 - Mercury Mechanical, ‘PR32 - Domestic Water System Description’, 16 September 2014 – Bundle of documents in relation to Water PPP – Page 1164.
- A36384755 - Capita, ‘NEC 3 Supervisor’s Report No. 45’, January 2015 – Bundle of documents in relation to Water PPP – Page 1168.
- A33870103 – Report prepared by DMA Water Treatment Ltd titled “L8 Risk Assessment (Pre-Occupancy) NHS Greater Glasgow and Clyde South Glasgow University Hospital” dated 1 May 2015 relating to site assessment concluding on 29 April 2015 – Bundle of documents for the Oral hearing commencing on 12 June 2023 – Bundle 6 – Miscellaneous documents – Page 122.
- A44312702 - DMA water, ‘Gap Analysis of L8/HSG 274 and SHTM 04-01 requirements’, 8 March 2016 – Bundle of documents in relation to Water PPP – Page 1208.
- A44976593 - Mercury, ‘Domestic Water System Sample Schedule’, 16-17 November 2016 – Bundle of documents in relation to Water PPP – Page 1217.
- A33869858 - ‘Item 487 – Irrigation FM first tickets’, 29 November 2016 – Bundle of documents in relation to Water PPP – Page 1221.
- A32402296 - Capita, ‘Stage 3 Adult and Childrens' Hospital and Energy Centre Final Defects Certificate 26.01.2017' – Bundle of documents in relation to Water PPP – Page 1222.
- A44312599 - Legionella control, ‘Legionella Management and Compliance Audit – Domestic Water Systems’, 4 May 2017 – Bundle of documents in relation to Water PPP – Page 1236.
- A41890259 – PAG Minute dated 6 February 2018 – Cuprividus – Aseptic Pharmacy RHC – Bundle of documents for the Oral hearing commencing on 12 June 2023 in relation to the Queen Elizabeth University Hospital and the Royal Hospital for Children, Glasgow – Bundle 2 – Problem Assessment Group Meeting Minutes (PAG Minutes) – Page 82.
- A33870243 – Report by DMA Canyon Ltd titled “L8 Risk Assessment GGC QEUH and RHC following site surveys in September 2017, October 2017, gap analysis in January 2018 and review date September 2018 – Bundle of documents for the Oral hearing commencing on 12 June 2023 – Bundle 6 – Miscellaneous documents – Page 416.
- A40732034 – Draft meeting report prepared by Dr Susanne Lee dated 25 April 2018 - Bundle 8 – supplementary documents for the Oral hearing commencing on 12 June 2023 – Page 134.
- A33795394 - Innovated Design Solutions, ‘Forensic Analysis Report’, 10 May 2018 – Bundle of documents in relation to Water PPP – Page 1266.

- A44311873 - Intertek, water inlet valve report number ITSS-0718-0001W, 11 July 2018 – Bundle of documents in relation to Water PPP – Page 1358.
- A33795375 – Report prepared by Intertek dated 11 July 2018 – Bundle of documents for the Oral hearing commencing on 12 June 2023 – Bundle 6 – Miscellaneous documents - Page 632
- A33869865 - 'Item 487 – Irrigation System comments', 19 July 2018 – Bundle of documents in relation to Water PPP – Page 1363
- A33870454 - DMA Canyon, 'Water System Risk Assessment' January 2019 – Bundle of documents in relation to Water PPP – Page 1364.
- A44312419 - Intertek, 'Examination of Corroded Valve Body', January 2019 – Bundle of documents in relation to Water PPP – Page 1377.
- A41501722 – The Herald on Sunday page 9 article "Early fungal outbreaks at hospital revealed" dated 26 May 2019 – Bundle of Documents for the Oral Hearing Commencing 12 June 2023 – Bundle 5 – Communications Documents – Page 313
- A43262538 - Scottish Water Byelaws Inspection Report, 28 February 2020 – Bundle of documents in relation to Water PPP – Page 1390.
- A44311662 - Element Materials Technology certificate ref no: E 105723, 14 October 2021 – Bundle of documents in relation to Water PPP – Page 1398.
- A44311682 - Element Materials Technology certificate ref no: E 105725, 14 October 2021 – Bundle of documents in relation to Water PPP – Page 1399.
- A44311652 - Element Materials Technology certificate ref no: E 105724, 14 October 2021 – Bundle of documents in relation to Water PPP – Page 1400.
- A44311688 - Element Materials Technology certificate ref no: E 105722, 14 October 2021 – Bundle of documents in relation to Water PPP – Page 1401.
- A44312654 - Pro Lp Consulting Ltd, Authorising Engineer Water Systems Management and Compliance Audit of NHS Water Systems, 28 February and 1 March 2022 – Bundle of documents in relation to Water PPP – Page 1402.
- A44312832 - Pro Lp Consulting Ltd, Authorising Engineer Water Systems Management and Compliance Audit of NHS Water Systems, 11 January 2023 – Bundle of documents in relation to Water PPP – Page 1420.
- A43262488 - Scottish Water Byelaws Inspection Report, 10 March 2023 – Bundle of documents in relation to Water PPP – Page 1446.
- A44039957 - Multiplex Construction Europe Limited, Response to s.21 Notice number 8 – Bundle of documents in relation to Water PPP – Page 1451.

5. Incoming mains supply

5.1. The QEUH and RHC are supplied by two incoming mains supplies from Scottish Water,[1] known as the Hardgate Road and Govan Road supply.

[1] A35823695 - 'PR32 - Domestic Water System Description' – Bundle in relation to Water PPP – Page 1164.

5.2. SHTM 04-01 gives comprehensive advice and guidance on water safety for healthcare premises. That guidance advises:

> "Normally, the source of water supply to healthcare premises is by one or more service pipe connections from the mains of the water supply authority."[2]

5.3. Having two incoming mains provides continuity of the water supply in the event that one supply fails. Both supplies enter the building in the basement manifold room and basement tank room.

Bypass pipes

5.4. There is a potentially deficient feature in respect of the bypass pipes. These are sections of pipework which lead directly from the public water mains to a location after the booster pumps and in doing so bypass the filters designed to remove unwanted elements from the public supply before use in the hospitals. The concern is that, when they were in use, the water in the hospital system would not be as clean as had been intended.

5.5. The Inquiry team understand that DMA Water Treatment Ltd (DMA) were instructed in the regulatory role of 'Legionella Risk Assessor', an independent professional advisor to the NHS Board tasked with, among other things, providing a Legionella Risk Assessment.[3] DMA issued an L8 Legionella Risk Assessment on 1 May 2015.[4] This noted a number of concerns in relation to the water systems at the hospitals. Among other things, the report advised:

> "There was bypass pipework set up to run from the Hardgate Road mains to the domestic (Bulk) water supply system connecting in after the Booster Pumps (5.0 Bar set). This was noted during DMAs initial site walk round and reported to Estates. DMA again noted this during the site survey of the CWSTs [Cold Water Storage Tanks] on 02/04/15 and again reported this to Estates."[5]

5.6. The pipework bypassed all CWSTs and filtration sets.[6] DMA noted this may have led to sediment and other debris, which would otherwise have been removed by the filtration set, being introduced into the system. DMA advised that this could be a contributory factor to the out of specification microbiological results that had recently been recorded in an NHS sampling

[2] A32354164 - SHTM 04-01 Part A, July 2014 – Bundle in relation to Water PPP – Page 269. The same provision is in v1 of that guidance from August 2011 (archived July 2014).
[3] A33103409 - SHTM 04-01 Part B, July 2014 – Bundle in relation to Water PPP – Pages 423 and 424.
[4] A33870103 – DMA L8 Risk Assessment, 1 May 2015 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 122.
[5] A33870103 – DMA L8 Risk Assessment, 1 May 2015 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 206.
[6] A33870103 – DMA L8 Risk Assessment, 1 May 2015 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 212.

programme.[7] The Inquiry team understand 'out of specification' to mean water samples where particular microbe levels are exceeded. In such an event escalation procedures and remedial actions are recommended.[8]

5.7. SHTM 04-01 advises that deposits of sediment and debris in hospital pipework can give rise to breeding grounds for health debilitating bacteria as well as biofilms which can ultimately cause deterioration of adjacent material surfaces. To avoid these potentially damaging circumstances, the SHTM provides that all incoming cold water supplies destined for domestic use within NHS Scotland premises should be filtered.[9] The SHTM also describes filtration as: "essential for healthcare premises pipework systems" to maintain hygienic conditions."[10]

5.8. DMA were advised in mid-April 2015 that the bypass had been removed,[11] though information from Estates staff suggested it was in place for a number of weeks.[12]

5.9. For the period the bypass was in place and in use it is a potentially deficient feature for the purposes of Glasgow III.

Inlet valves

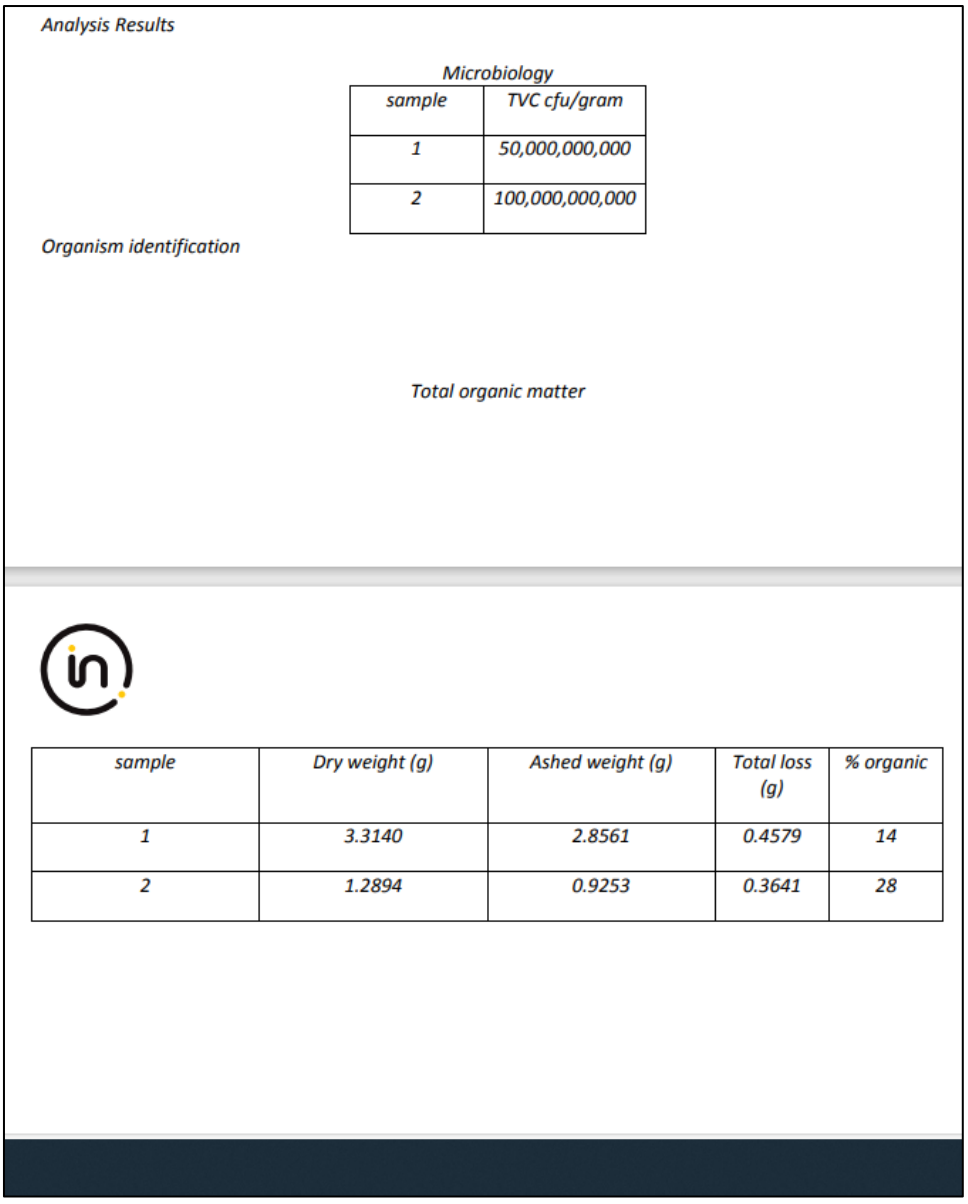
5.10. There is potentially deficient feature in respect of the integrity of inlet valves on the mains supply into QEUH. Deposits were observed on the inside surface of a valve, though limited information is available as to the significance of this.

5.11. On 11 July 2018, a mains water inlet valve from QEUH was analysed for microbial contamination by Intertek.[13] The laboratory was asked to investigate deposits visible on the internal surface of the pipework."[14] Intertek advised:

"The meter was removed from the pipe to gain access to all areas of the

[7] A33870103 – DMA L8 Risk Assessment, 1 May 2015 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Pages 212 and 136.
[8] A33870103 – DMA L8 Risk Assessment, 1 May 2015 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 374 features a diagram whereby this understanding has been derived.
[9] A33103412 – SHTM 04-01 Part E, Aug 2015 – Bundle in relation to Water PPP – Page 674; The same provision can be found in the preceding guidance A46213604 - SHTN 2, Dec 1999 – Bundle in relation to Water PPP – Page 81.
[10] A33103412 – SHTM 04-01 Part E, Aug 2015 – Bundle in relation to Water PPP – Page 616; The same provision can be found in the preceding guidance A46213604 - SHTN 2, Dec 1999 – Bundle in relation to Water PPP – Page 12.
[11] A33870103 – DMA L8 Risk Assessment, 1 May 2015 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 206.
[12] A33870103 – DMA L8 Risk Assessment, 1 May 2015 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 212.
[13] A44311873 - Intertek water inlet valve report, 11 July 2018 – Bundle in relation to Water PPP – Page 1359.
[14] A44311873 - Intertek water inlet valve report, 11 July 2018 – Bundle in relation to Water PPP – Page 1359.

unit. When removing the meter further deposits were found on the internal surface of the pipe and on the casing of the meter fan. The deposits were white in colour and solid to the touch."[15] "2 samples of the deposits were taken for analysis"[16]



Analysis Results

Microbiology

sample	*TVC cfu/gram*
1	*50,000,000,000*
2	*100,000,000,000*

Organism identification

Total organic matter

sample	*Dry weight (g)*	*Ashed weight (g)*	*Total loss (g)*	*% organic*
1	*3.3140*	*2.8561*	*0.4579*	*14*
2	*1.2894*	*0.9253*	*0.3641*	*28*

5.12. The screenshot above notes the results from Intertek's report. The significance of these results is not yet known to the Inquiry team. These inlet valves are potentially deficient features for the purposes of Glasgow III.

[15] A44311873 - Intertek water inlet valve report, 11 July 2018 – Bundle in relation to Water PPP – Page 1359.
[16] A44311873 - Intertek water inlet valve report, 11 July 2018 – Bundle in relation to Water PPP – Pages 1360 to 1362.

Double check valves

5.13. The potential for 'backflow' at the mains input to QEUH is a potentially deficient feature of the water system. 'Backflow' occurs where a system is designed for water flow in one direction, but a feature of its operation (e.g. a pressure difference in certain circumstances) creates the possibility that water might be caused to flow in the opposite direction. At this location the concern was that water taken into the hospital at the mains input might be caused to flow back out, and into the public water mains.

5.14. A Scottish Water bylaws inspection was conducted in June 2019. GGC have advised the Inquiry team they are unable to locate a copy of Scottish Water's original report, however, note it identified non-compliances with Scottish Water bylaws.[17] GGC advise that, in response, a double check valve was installed on the incoming mains supply, preventing backflow from the Hospital water system into the Scottish Water main system.[18] A bylaw rectification report issued by Water & Pipeline Services Ltd notes this was completed by 14 June 2019.[19]

5.15. The potential for backflow on incoming supplies throughout other areas of the QEUH was also identified as a potentially deficient feature. Scottish Water Byelaws Inspection Reports of 28 February 2020 and 10 March 2023 identified numerous points across the site where there was insufficient backflow protection, representing a contamination risk.[20] It is not known what remedial actions if any have been taken to address those concerns. These issues are potentially deficient features for the purposes of Glasgow III.

Drain points and low turnover

5.16. The existence of certain points in the incoming water system where there was low turnover, and therefore a lack of regular and normal opportunities for flushing, is a potentially deficient feature of the water system. Specific concern was raised regarding the potential for contamination at drain points which were little-used. Without a means of regular flushing, whether through normal use or a specific flushing regime, a risk may arise of that site becoming contaminated.

5.17. DMA issued a further Legionella Risk Assessment on 25 April 2018 following

[17] A44311444 - Parts 2(i), (ii) and (iii) of GGC response to s.21 Notice 8 – Bundle in relation to Water PPP – Page 995.
[18] A44311369 - Parts 1(iii), 1(iv) & 2(i) of GGC response to s.21 Notice 8 – Bundle in relation to Water PPP – Page 985.
[19] A44313070 - Water & Pipeline Services Ltd, Scottish Water Byelaw rectification report, undated – Bundle in relation to Water PPP – Page 1020.
[20] A43262538 - Scottish Water Byelaws Inspection Report, 28 February 2020 – Bundle in relation to Water PPP – Page 1390; A43262488 - Scottish Water Byelaws Inspection Report, 10 March 2023 – Bundle in relation to Water PPP – Page 1446.

site surveys in October 2017 and a gap analysis review meeting in January 2018. The Inquiry team again understand this was in their regulatory role of 'Legionella Risk Assessor'. That report noted:

> "DMA have described both the Govan Road and Hardgate Road supplies as medium risk due to the drain points etc. on the pipework for which there is no record of flushing. We have described the Hardgate Road (small) as a High Risk due to the low turnover to the Fire Suppression system."[21]

5.18. A review of DMA's recommendations dated 29 January 2019 suggests these drain points were incorporated into the flushing regime.[22] The existence of these points of low turnover and a lack of regular and normal opportunities for flushing is potentially deficient feature for the purposes of Glasgow III.

6. Raw water storage tanks

6.1. The guidance in SHTM 04-01 is clear:

> "Water is stored in healthcare premises for the following reasons: · to provide a reserve supply during failure of the main cold water supply; · to reduce the maximum demand on the cold water main; · to provide accommodation for the expansion of any water subjected to heat, that is, hot water and heating services; · to reduce the pressure from that of the distribution system."[23]

> "The following generally covers the range of uses [of stored water]: · cold water services, domestic, laundry etc; · cold water feed to hot water services; · drinking water supplies; · treated cold water for laundries, heating etc when local supplies are unsuitable; · break tanks on cold water supplies serving points of use where backflow is, or is likely to be, harmful to health due to a substance representing a serious hazard, for example, supplies to pathology laboratories; · feed and expansion for heating service; · fire-fighting"[24]

> "Storage should be designed to minimise residence time in the cistern and maximise turnover of water to avoid stagnation and deterioration of water quality."[25]

[21] A33870243 – DMA Canyon L8 Risk Assessment, Final Submission 25 April 2018 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 421.
[22] A33869445 – GGC Review of DMA Recommendations, 29 January 2019 – Bundle 8 for Oral hearing commencing 12 June 2023 – Pages 87 and 88.
[23] A32354164 - SHTM 04-01 Part A, July 2014 – Bundle in relation to Water PPP – Page 283. The same provision is in v1 of that guidance from August 2011 (archived July 2014).
[24] A32354164 - SHTM 04-01 Part A, July 2014 – Bundle in relation to Water PPP – Page 283. The same provision is in v1 of that guidance from August 2011 (archived July 2014).
[25] A32354164 - SHTM 04-01 Part A, July 2014 – Bundle in relation to Water PPP – Page 283. The same provision is in v1 of that guidance from August 2011 (archived July 2014).

6.2. The incoming mains to the QEUH and RHC supply two raw water storage tanks. A separate Trades Water tank supplies various outlets such as the fire suppression system for the helipad.

6.3. Once water from the raw water storage tanks is filtered, it is pumped to two potable bulk cold water storage tanks. The arrangement of these tanks allows them to be maintained without disrupting the building's water supply. The water levels in the tanks can also be adjusted to reflect water demand by the use of float switches so the tanks can achieve optimal turnover of water.

6.4. In total there are 5 water storage tanks in the building. Water is pumped from the potable bulk cold water storage tanks via main distribution risers to serve plant rooms, where it is distributed to supply cold water across the hospital and the energy centre.

Tank lid hollow supports

6.5. The use of certain types of hollow tank lid supports within the water tanks is a potentially deficient feature. On 19 November 2013 Health Facilities Scotland (HFS) issued an alert advising that the use of hollow pipes as lid supports in cold water storage tanks was likely to lead to stagnation and harbouring of harmful micro-organisms. HFS recommended that hollow pipes be replaced with solid structures.[26]

6.6. GGC have advised the Inquiry that hollow lid supports were replaced with solid lid supports on 25 January 2015.[27] Whilst there were hollow tank lid supports within the water tanks this was a potentially deficient feature for the purposes of Glasgow III.

Deadlegs around the water tanks

6.7. The existence of 'deadlegs' around the water tanks at QEUH is a potentially deficient feature. A 'deadleg' arises where some arrangement of a water system creates a location where water may become stagnant, for example where the configuration is open only at one end, or where it is open at both ends but used in such a way that water does flow through the location thereby flushing it. Stagnancy creates a risk of allowing organisms to grow in that location.

6.8. In their 2015 Legionella Risk Assessment, DMA noted:

> "At the time of survey DMA noted that the Hardgate Road supply into Raw Water Tank 1A has been isolated creating a deadleg and NHS

[26] A33625416 - Estates and Facilities Alert EFA/2013/004 – Bundle in relation to Water PPP – Page 812.
[27] A44311369 - Parts 1(iii), 1(iv) & 2(i) of GGC response to s.21 Notice 8 – Bundle in relation to Water PPP – Page 979.

> Estates confirmed this had been isolated for a number of weeks pending repair by Mercury Engineering. This has still not been completed at the time of this report. The outlet from this tank has remained live during this period which means this is acting as a balance tank with no through flow of water leading to stagnation and film formation on the water surface."[28]

6.9. A similar set up was noted on the Trades system, creating stagnation in both affected tanks. DMA advised this may be contributing to any out of specification microbiological results.[29]

6.10. DMA recommended that tank 1A be completely isolated from service until the mains inlet could be repaired, and the CWST cleaned and disinfected prior to re-use (including the mains line).[30] A review of DMA's recommendations dated 16 December 2018 stated this work was completed by Mercury of behalf of Multiplex in 2015.[31] Regarding the Trades system, the same review noted that the Trades tank in question provided water to fire fighting services for the helipad only and was isolated from the rest of the domestic water system.[32]

6.11. DMA issued a further Legionella Risk Assessment on 25 April 2018.[33] That report appears to identify the same Trades Water tank deadleg highlighted in DMA's 2015 assessment.[34] DMA advised:

> "One side of the Trades tank was valved off due to a reported inlet valve issue in 2015 (though tank full with signs of stagnation). It would appear that this tank has been offline since the construction phase."[35] "The RHS 'Trades' Water tank appears to have been isolated for approximately 3 years with no recorded flushing of the deadleg this has created."[36]

6.12. In their 2018 report DMA recommended that the Trades water tank should be incorporated into the weekly flushing regime until such times as the CWST

[28] A33870103 – DMA L8 Risk Assessment, 1 May 2015 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 212.
[29] A33870103 – DMA L8 Risk Assessment, 1 May 2015 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 137.
[30] A33870103 – DMA L8 Risk Assessment, 1 May 2015 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 212.
[31] A33872975 - GGC Review of DMA Recommendations, 16 December 2018 – Bundle in relation to Water PPP – Page 845.
[32] A33872975 - GGC Review of DMA Recommendations, 16 December 2018 – Bundle in relation to Water PPP – Page 847.
[33] A33870243 – DMA Canyon L8 Risk Assessment, Final Submission 25 April 2018 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 416.
[34] A33870243 – DMA Canyon L8 Risk Assessment, Final Submission 25 April 2018 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 464.
[35] A33870243 – DMA Canyon L8 Risk Assessment, Final Submission 25 April 2018 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 469.
[36] A33870243 – DMA Canyon L8 Risk Assessment, Final Submission 25 April 2018 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 421.

issue was corrected."[37] DMA recommended that the tank be cleaned and disinfected prior to it being reinstated – or if not required drained and left isolated, ensuring any deadlegs created on the inlet and/or outlet were removed or incorporated into the site flushing regime.[38]

6.13. A GGC review of DMA's recommendations by GGC dated 29 January 2019 stated that both Trade tanks were cleaned, with the RHS tank drained and isolated.[39] Elsewhere the review stated the RHS tank was removed.[40] GGC have also advised the Inquiry that one of two 'trade' water tanks was taken off line and the deadleg removed in July 2018.[41]

6.14. These two examples are potentially deficient features for the purposes of Glasgow III.

Temperature rise / lack of flow in the tank system

6.15. A series of concerns were raised regarding temperature control and turnover of water in the tank system. It was speculated that the two may be linked, such that a lower turnover of water would mean water remaining in the tank in question for longer than envisaged, as a result of which contamination would be a possible result, either because the water became stagnant or because it allowed the water to rise in temperature. Either of those may pose a risk of growth occurring in the water. The existence of such an arrangement would be a potentially deficient feature within a water system.

6.16. DMA's 2015 report noted:

> "Greater than 2°C temp rise from mains to stored water in CWST [Cold Water Storage Tank] 1A and 1B."[42]

6.17. According to DMA, the temperature of the water stored in the tanks should have not been more than 2°C higher than the incoming mains. It was noted that poor control over water temperature may lead to Legionella colonising and proliferating in the tank, producing a possible source of bacteria to infect other water services downstream. [43] DMA recommended further monitoring of

[37] A33870243 – DMA Canyon L8 Risk Assessment, Final Submission 25 April 2018 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 464.
[38] A33870243 – DMA Canyon L8 Risk Assessment, Final Submission 25 April 2018 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 469.
[39] A33869445 – GGC Review of DMA Recommendations, 29 January 2019 – Bundle 8 for Oral hearing commencing 12 June 2023 – Page 89.
[40] A33869445 – GGC Review of DMA Recommendations, 29 January 2019 – Bundle 8 for Oral hearing commencing 12 June 2023 – Page 87.
[41] A44311369 - Parts 1(iii), 1(iv) & 2(i) of GGC response to s.21 Notice 8 – Bundle in relation to Water PPP – Page 983.
[42] A33870103 – DMA L8 Risk Assessment, 1 May 2015 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 143.
[43] A33870103 – DMA L8 Risk Assessment, 1 May 2015 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 211.

the storage temperatures, with capacities of the tanks altered to match usage requirements if necessary.[44]

6.18. A GGC review of DMA's recommendations by GGC dated 16 December 2018 stated this concern has diminished with full occupancy of the building and increased water turnover.[45] A DMA Gap Analysis of 8 March 2016 notes that six monthly condition/temperature inspections were taking place for the cold water storage tanks.[46] However, in relation to "annual cleaning and disinfection of CWST and downservices… TVC [Total Viable Counts] and Legionella samples should be taken upon completion of disinfection works", the same report narrated that this had not been carried out.[47]

6.19. Water tank storage temperature was again highlighted as a concern in DMA's 2018 report:

> "Storage temperate in 2B combined with heavier water mark may indicate this CWST is not turning over as well as the others."[48]

6.20. DMA noted that the storage temperate in 2B should be monitored and CWSTs balanced."[49] A review of DMA's recommendations dated 29 January 2019 suggests that tanks were cleaned in July 2018 in response to this concern.[50]

6.21. In March 2019 HFS issued a Water Management Issues Technical Review.[51] HFS noted:

> "From the information provided the Hardgate Road tank is not turning over as much as the Govan Road tank." "the water meter results show one tank turnover less the other and therefore a risk of stagnation exists"[52]

6.22. HFS suggested the tanks were checked for balancing,[53] and that turnover of

[44] A33870103 – DMA L8 Risk Assessment, 1 May 2015 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 143.
[45] A33872975 - GGC Review of DMA Recommendations, 16 December 2018 – Bundle in relation to Water PPP – Page 846.
[46] A44312702 - DMA Gap Analysis, 8 March 2016 – Bundle in relation to Water PPP – Page 1212.
[47] A44312702 - DMA Gap Analysis, 8 March 2016 – Bundle in relation to Water PPP – Page 1213.
[48] A33870243 – DMA Canyon L8 Risk Assessment, Final Submission 25 April 2018 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 468.
[49] A33870243 – DMA Canyon L8 Risk Assessment, Final Submission 25 April 2018 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 468.
[50] A33869445 – GGC Review of DMA Recommendations, 29 January 2019 – Bundle 8 for Oral hearing commencing 12 June 2023 – Page 88.
[51] A33448015 – HFS Water Management Issues Technical Review – Bundle for Oral Hearing Commencing 12 June 2023 – Bundle 7 - Page 70
[52] A33448015 – HFS Water Management Issues Technical Review – Bundle for Oral Hearing Commencing 12 June 2023 – Bundle 7 - Page 118
[53] A33448015 – HFS Water Management Issues Technical Review – Bundle for Oral Hearing Commencing 12 June 2023 – Bundle 7 - Page 118

the tanks was checked, managed and recorded.[54] GGC have advised the Inquiry that in March 2019, Schneider Electric (Schneider) were engaged to monitor and control turnover of water in the storage tanks.[55]

6.23. GGC advise that in May 2020, increased Cold Water Storage tank Sampling was introduced as part of ongoing risk reduction actions and monitoring water quality."[56] It is not known whether these actions have resolved the concerns around temperature rise and lack of flow in the tank system.

6.24. These temperature differentials are potentially deficient features for the purposes of Glasgow III

Debris within tanks

6.25. A series of concerns were raised regarding debris within the tanks. The presence of debris poses a risk of contamination in two ways: the debris itself may be regarded as a contaminant; and the debris provides a surface upon which organic growth may occur.

6.26. DMA's 2015 report stated:

> "DMA noted small debris including washers in Bulk Water Tank 2B".[57] "The volume of debris within the water tanks appeared to be more than would be expected considering the Bulk Water tanks are fed via 0.5 micron filter sets."[58]

6.27. DMA recommended that tank 2B be cleaned to remove debris and then disinfected.[59]

6.28. The same concern was identified in DMA's 2018 report:

> "DMA noted small debris including washers in Bulk Water Tank 2B in our initial assessment from 2015 and these are still present."[60] "[Tank 2B] DMA were advised during the initial occupation phase that the filter system was bypassed due to issues with the pumps and filter set and this may have introduced debris (and potentially bacteria) into the system and as the tanks have not been cleaned since this time anything

[54] A33448015 – HFS Water Management Issues Technical Review – Bundle for Oral Hearing Commencing 12 June 2023 – Bundle 7 - Page 148
[55] A44311444 - Parts 2(i), (ii) and (iii) of GGC response to s.21 Notice 8 – Bundle in relation to Water PPP – Page 995.
[56] A44311369 - Parts 1(iii), 1(iv) & 2(i) of GGC response to s.21 Notice 8 – Bundle in relation to Water PPP – Page 987.
[57] A33870103 – DMA L8 Risk Assessment, 1 May 2015 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 212.
[58] A33870103 – DMA L8 Risk Assessment, 1 May 2015 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 144.
[59] A33870103 – DMA L8 Risk Assessment, 1 May 2015 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 144.
[60] A33870243 – DMA Canyon L8 Risk Assessment, Final Submission 25 April 2018 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 422.

flushed into the system may have colonised parts of the system."[61]

6.29. DMA recommended that tank 2B be cleaned to remove debris and then disinfected. A further recommendation was made to confirm the competency of staff completing CWST inspections and that inspections were being completed. DMA also advised that the filter system should be checked as the level of debris was unexpected downstream of a 0.2 micron filter. [62]

6.30. In response to this concern, GGC have advised the Inquiry that the bulk water tanks were cleaned in June-July 2018.[63] A further Legionella Risk Assessment was issued by DMA Canyon (formerly DMA Water Treatment Ltd) in January 2019. The Inquiry team understand this was in the regulatory role of 'Legionella Risk Assessor'. That report narrated:

> "The CWSTs were cleaned and disinfected in summer 2018 by DMA. Large amounts of debris were found in the water tanks, including large particles of rust coloured materials (particularly in the Govan Road supplied tanks), sponges in a Raw water tank (believed to have been left over from initial pre-handover cleaning and disinfections, bolts/washers in post filter tanks (again believed to have been left over from initial pre-handover cleaning and disinfection)."[64]

6.31. An Intertek report of 11 July 2018 notes that tests were conducted on debris recovered from the tank, indicating a large biofilm presence on the debris.[65] On biofilm, the report noted:

> "Any part of the system where the flow rate is slowed increases the chance of a biofilm forming as organisms are more likely to be able to attach to the surface. Increased surface area gives more opportunity for organisms to attach and a biofilm to form. Materials used in the construction of the water system have the potential to provide nutrients potentially increasing the natural fauna in the water…ambient temperature water offers better conditions for organisms to develop in higher concentrations- there are exceptions to this"
>
> A biofilm also supplies a degree of protection to the organisms living in it. The extracellular polymers secreted by the organisms and used as the building structure for the biofilm form a protective layer which provides more resistance to physical and chemical treatment than the organisms would have in their planktonic state. It is not unusual in

[61] A33870243 – DMA Canyon L8 Risk Assessment, Final Submission 25 April 2018 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 468.
[62] A33870243 – DMA Canyon L8 Risk Assessment, Final Submission 25 April 2018 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 468.
[63] A44311369 - Parts 1(iii), 1(iv) & 2(i) of GGC response to s.21 Notice 8 – Bundle in relation to Water PPP – Page 983.
[64] A33870454 - DMA Canyon Water System Risk Assessment, January 2019 – Bundle in relation to Water PPP – Page 1371.
[65] A33795375 – Intertek report 11 July 2018 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 642.

> biofilms to find a low number of dominant species although the total number of species could in reality be significantly higher."[66]

6.32. Baffles are features within a water system which are present to direct water flow. Their presence may constitute a potentially deficient feature, should they provide surfaces with a potential to contaminate water if organic material is able to grow on them.

6.33. DMA's 2018 report noted that in respect of the raw cold water storage tanks:

> "Raw Water CSWTs [sic]: Some evidence of biofilm forming on baffles at mains inlets, possibly due to splashing etc."[67]

6.34. DMA advised that baffles should be inspected periodically (e.g. monthly and cleaned as and when required.[68] It is not known to the Inquiry team what if any remedial action in addition to the cleaning of the tanks in summer 2018 was taken in response to this concern.

6.35. The existence of these debris and biofilm within the tanks and on baffles are potentially deficient features for the purposes of Glasgow III.

Screens around tanks

6.36. An absence of screening at certain locations around the water tanks is a potentially deficient feature of the system. Screening of parts which are open to the outside, such as vents, would reduce the potential for contaminants to enter. An absence of screening may in certain circumstances therefore create a risk of being a potential entry-point for contaminating material.

6.37. DMA's 2018 report stated that all raw and bulk cold water storage tanks should have suitable screens fitted to the 'warning pipe' and it should be confirmed that the overflow is suitably screened.[69]

6.38. SHTM 04-01 states:

> "Many hospitals…now store all water in tanks arranged to contain water of drinking quality, having sealed lids and screened vents. This offers complete flexibility, avoids problems with stagnation and is recommended practice."[70]

[66] A33795375 – Intertek report 11 July 2018 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 641 and 642.
[67] A33870243 – DMA Canyon L8 Risk Assessment, Final Submission 25 April 2018 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 435.
[68] A33870243 – DMA Canyon L8 Risk Assessment, Final Submission 25 April 2018 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 435.
[69] A33870243 – DMA Canyon L8 Risk Assessment, Final Submission 25 April 2018 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 436.
[70] A32354164 - SHTM 04-01 Part A, July 2014 – Bundle in relation to Water PPP – Page 303. The same provision is in v1 of that guidance from August 2011 (archived July 2014).

6.39. In response to this concern GGC have advised the Inquiry that insect screens were fitted to the external overflow pipe on 18 June 2018.[71]

6.40. The absence of these screens are potentially deficient feature for the purposes of Glasgow III

Corrosion and non-compliant fittings in tanks

6.41. The presence of corrosion on tank fittings is a potentially deficient feature, because deterioration of the corroded part could produce material, such as rust, which could detach from the part and enter the water supply. A series of such concerns were identified for elements of the water system around the tanks.

6.42. There is an undated a tank report/investigation produced by Nicholson Plastics Ltd, believed to date from July 2021.[72] The report appears to have been instructed by DMA following concerns relating to corroding fittings in the tanks and resulting debris, which was considered unusual for the age of the tanks (approximately 8 years).[73] The report noted:

> "Immediately on attendance it was evident corrosion is taking place on fasteners, strengthening tie bars and internal dividing wall supports. This occurs above and below the water line but is more prevalent above the water line where oxidisation occurs. Resultantly there is continual debris and contaminants from the corrosion entering the stored water either in solid or liquid form."[74] "As time passes the fasteners & more importantly retaining tie bars will weaken through further corrosion which will result in further contamination, potential weaknesses within the integrity of the seals on the tank panels as forces are lessened and may result in leaks and potentially catastrophic failure".[75]

6.43. It was also noted that marking stamps on fasteners showed non-compliant use of sub-standard A2 stainless steel (grade 1.4301) instead of compliant A4 (grade 1.4401), which is described as the expected minimum specification for a tank within a hospital.[76] The report advised that sample steel components could be removed from the tank and sent for analysis for avoidance of doubt:

> "The importance of the use of the correct compliant grade of stainless steel cannot be understated particularly when coming into contact with

[71] A44311369 - Parts 1(iii), 1(iv) & 2(i) of GGC response to s.21 Notice 8 – Bundle in relation to Water PPP – Page 983.
[72] A44312597 - Nicholson Plastics Tank Report – Bundle in relation to Water PPP – Page 1003. A44311444 - Parts 2(i), (ii) and (iii) of GGC response to s.21 Notice 8 – Bundle in relation to Water PPP – Page 997 advises the tank report was conducted in July 2021.
[73] A44312597 - Nicholson Plastics Tank Report – Bundle in relation to Water PPP – Page 1003.
[74] A44312597 - Nicholson Plastics Tank Report – Bundle in relation to Water PPP – Page 1003.
[75] A44312597 - Nicholson Plastics Tank Report – Bundle in relation to Water PPP – Page 1016.
[76] A44312597 - Nicholson Plastics Tank Report – Bundle in relation to Water PPP – Page 1003.

levels of free chlorine no matter how diluted."[77]

6.44. Mesh openings were also identified on vent air intakes, allowing the tank to 'breath'. The openings in this mesh were recorded to be greater than the permitted standard of 0.65mm, enabling air containing contaminants to be drawn into the tanks under heavy draw off. Damaged & misaligned lid cover panels were also identified that may have contributed to this issue.[78]

6.45. GGC have advised the Inquiry that, following Nicholson Plastics' tank inspection, testing of fittings was undertaken.[79] Testing of rods and bolts was conducted on 14 October 2021 but the test certificates provided do not explain the purpose of the tests or the meaning of the results, but it does appear that some of these elements are made from steel that appears to be out of specification.[80]

6.46. The Inquiry team understand that Pro Lp Consulting Ltd were instructed in the regulatory role of 'Authorising Engineer', to act as an independent professional advisor to the NHS Board. In terms of SHTM 04-01, an Authorising Engineer acts as an assessor who, among other things, monitors the performance of the water service and provides an annual audit to the NHS Board.[81] A Pro Lp Consulting Ltd Authorising Engineer Management and Compliance Audit dated 28 February and 1 March 2022 advised: "The records show that the cold-water storage tanks were cleaned and disinfected in October 2021 and January 2022."[82] It is not known if this was undertaken in response to the Nicholson Plastics report or resolved the concern regarding corroding fittings.

6.47. In any event, the Compliance Audit also stated: "Legionella sampling has been undertaken on a monthly basis across the hospital and includes testing on the cold water storage tanks. There have not been any positive legionella tests completed in the past year."[83] The audit goes on to explain that a system for sampling water and recording the remedial actions for any out of specification results has been in place since 2018. A repeat audit by Pro Lp Consulting Ltd dated 11 January 2023 advised that cold water storage tanks are cleaned and disinfected on an annual basis.[84]

[77] A44312597 - Nicholson Plastics Tank Report – Bundle in relation to Water PPP – Page 1016.
[78] A44312597 - Nicholson Plastics Tank Report – Bundle in relation to Water PPP – Page 1003.
[79] A44311444 - Parts 2(i), (ii) and (iii) of GGC response to s.21 Notice 8 – Bundle in relation to Water PPP – Page 997.
[80] A44311662 - Certificate ref: E 105723 – Bundle in relation to Water PPP – Page 1398; A44311682 - Certificate ref: E 105725 – Bundle in relation to Water PPP – Page 1399; A44311652 - Certificate ref: E 105724 – Bundle in relation to Water PPP – Page 1400; A44311688 - Certificate ref: E 105722 – Bundle in relation to Water PPP – Page 1401.
[81] A33103409 - SHTM 04-01 Part B, July 2014 – Bundle in relation to Water PPP – Pages 423.
[82] A44312654 - Pro Lp Consulting Ltd Audit 2022 – Bundle in relation to Water PPP – Page 1418.
[83] A44312654 - Pro Lp Consulting Ltd Audit 2022 – Bundle in relation to Water PPP – Page 1418.
[84] A44312832 - Pro Lp Consulting Ltd Audit 2023 – Bundle in relation to Water PPP – Page 1443.

6.48. The existence of these non-compliant stainless steel tank fittings is a potentially deficient feature for the purposes of Glasgow III

Water testing of tanks

6.49. A series of concerns arose as a result of testing undertaken at QEUH, the nature of which depended upon the particular testing being undertaken.

6.50. A timeline of incidents produced by the GGC Oversight Board noted in August 2018 that:

> "Water testing of tank room shows water mostly negative post filtration but raw water tanks have positive results from drain connections which are not capped or sanitised. This action is to be progressed. Bulk storage tanks also positive - believed to be due to environmental conditions – noted to be cockroaches, fungal odour, room not ventilated, water ingress and dried algae on floor. Area to be disinfected, repainted with anti-fungal paint, repairs made and pest control called in. Testing to be done once work completed."[85]

6.51. The same timeline noted that in December 2018, the first set of water samples from the tank room returned with good results.[86] However the timeline noted that in June 2019:

> "continual fungi results from water tanks but it was possibly due to cross-contamination during the sampling process which has now been modified to ensure this does not occur. Noted smell of mustiness from sprinkler tap room which was used as a storage room. Agreed area is to be cleaned and sanitised, tanks repaired and sealed to the floor."[87]

6.52. It was also noted in the timeline that, by July 2019, work to address mould in 'the water tank' had been carried out.[88] However it was noted that in August 2019:

> "Testing showed positive results for Ps [Pseudomonas] and coliforms from the main water tank room. Two filtered water tanks and an outlet downstream of the tanks in the children's OPD [Out Patient Department] on ground floor were sampled and have been submitted to lab. Noted that water sampling is identifying consistent activity for mould and yeast which have been sent for typing. Noted that where counts are low this is often due to dirty taps or sampling errors. Need to know coliform counters and results of nearby outlets upstream and downstream, and

[85] A33448013 – Oversight Board Infection Timeline - Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 960.
[86] A33448013 – Oversight Board Infection Timeline - Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 962.
[87] A33448013 – Oversight Board Infection Timeline - Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 965.
[88] A33448013 – Oversight Board Infection Timeline - Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 966.

results following disinfection and resampling. The ongoing issues in the basement plant room in terms of yeast and mould need to be further investigated"[89]

6.53. It was noted in the timeline that, in October 2019:

"Testing of basement tanks post filter shows Delftia in one tank and room. One Ps found in the drain points and TVCs are showing in raw water tank but only in certain lines. Noted that room has high level of humidity and musty smell."[90]

6.54. It was noted in the timeline that, in December 2019:

"Sampling of the air vents at top of tanks to be performed to see if anything there which might Infect tanks. Discussion will also be held with F&E [Facilities & Estates] to see what options there are to increase ventilation which is an issue. Re-sampling also to be done to determine if air in room is infecting the tank."[91]

6.55. A report produced for an GGC Acute Infection Control Committee (AICC) meeting of 30 September 2020 stated:

"A number of out of specs have been identified in the RAW water tank samples drains over the month:-

SAB's

H. Hyphomycete

M. Sterilia

Delfia Acidovorans

Acinetobacter Ursingii

TVC's

Roseomonas Mucosa

Enhydobacter Aerosaccus

Acinetobacter Iwoffii

Sphingobium Xenophagum"[92]

[89] A33448013 – Oversight Board Infection Timeline - Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 966.
[90] A33448013 – Oversight Board Infection Timeline - Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 967.
[91] A33448013 – Oversight Board Infection Timeline - Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 968.
[92] A32700430 - AICC paper 30 September 2020 – Bundle in relation to Water PPP – Page 914.

6.56. A report appearing to date from 8 December 2020 and produced for an GGC AICC meeting noted:

> "A number of out of specs (16) have been identified in the RAW water tank over the month for TVC's, moulds and in some cases GNB's"[93]

6.57. As discussed above, Pro Lp Consulting Ltd's Authorising Engineer Management and Compliance Audit dated 28 February and 1 March 2022 advised that the cold-water storage tanks were cleaned and disinfected in October 2021 and January 2022."[94] Pro Lp Consulting Ltd's repeat audit dated 11 January 2023 advised that cold water storage tanks are cleaned and disinfected on an annual basis.[95] It is not known if this has resolved the above concerns.

6.58. The presence of these organisms in the tanks as discovered by these tests is a potentially deficient feature for the purposes of Glasgow III.

7. Filtration and filtration control

7.1. Concerns were raised at certain times regarding the operation of the filtration system, either because it was set up in such a way as to exclude useful functions which it might perform or had been operated in a way as to create potential risks to the safety of the water supply.

7.2. According to SHTM 04-01, filtration is normally used to prevent ingress of suspended solids into plant and pipework, and as such may be defined as the process of separating solids from liquids using a porous medium.[96]

7.3. The SHTM provided that all incoming cold water supplies destined for domestic use within NHS Scotland premises should be filtered.[97] 'Absolute filtration' of a specified size indicates that the filtration plant can remove 99.9% of all particles above a given size. 'Nominal filtration' is referred to when 95% of all particles above a specified size will be removed.[98]

7.4. The level of filtration within NHS Scotland where stainless steel pipework systems are installed should be 0.5 micron absolute, although this can be

[93] A32700431 - AICC paper 8 December 2020 – Bundle in relation to Water PPP – Page 925.
[94] A44312654 - Pro Lp Consulting Ltd Audit 2022 – Bundle in relation to Water PPP – Page 1418.
[95] A44312832 - Pro Lp Consulting Ltd Audit 2023 – Bundle in relation to Water PPP – Page 1443.
[96] A33103412 – SHTM 04-01 Part E, Aug 2015 – Bundle in relation to Water PPP – Page 675. The same provision can be found in the preceding guidance A46213604 - SHTN 2, Dec 1999 – Bundle in relation to Water PPP – Page 82.
[97] A33103412 – SHTM 04-01 Part E, Aug 2015 – Bundle in relation to Water PPP – Page 674. The same provision can be found in the preceding guidance A46213604 - SHTN 2, Dec 1999 – Bundle in relation to Water PPP – Page 81.
[98] A33103412 – SHTM 04-01 Part E, Aug 2015 – Bundle in relation to Water PPP – Page 675. The same provision can be found in the preceding guidance A46213604 - SHTN 2, Dec 1999 – Bundle in relation to Water PPP – Page 82.

relaxed to 5 microns on receipt of written guarantees from the pipework and fittings manufacturers that the system should have a life-span not less than that provided by a plastic pipework installation.[99]

7.5. The filtration plant should be capable of providing fully automatic operation and include self-cleaning and back-washing modes so that the filter medium does not become a reservoir of bacteria capable of contaminating the service pipework.[100]

Reconfiguration in event of fault

7.6. A potentially deficient feature arises in respect of the connection of particular filtration units to particular water tanks. In other words, due to these direct connection filtration units are thus unable to cover shortfalls in the other tanks to which they are not connected.

7.7. DMA's report of 1 May 2015 stated:

> "The filtration units fill separate Bulk Water Tanks (filtration unit 1 supplying 1A & 1B and filtration unit 2 supplying 2A & 2B). There is no way to reconfigure set-up to allow the filtration units to fill the other tanks under fault conditions."[101]

7.8. It is not clear what remedial action was taken in respect of this, however GGC have advised the Inquiry that an additional filtration unit was fitted in the basement plantroom and commissioned in March 2019, increasing the number of units from two to three. The three units were commissioned within the BMS system by Schneider on a duty-duty-standby rotation allowing one unit to be offline for planned maintenance when required, leaving two units operational.[102]

7.9. The lack of a system to enable reconfiguration at handover is a potentially deficient feature for the purposes of Glasgow III.

Bypass of the filtration system

7.10. This potentially deficient feature is covered at Chapter 5 of this Note.

[99] A33103412 – SHTM 04-01 Part E, Aug 2015 – Bundle in relation to Water PPP – Pages 676 and 638. The preceding guidance A46213604 - SHTN 2, Dec 1999 – Bundle in relation to Water PPP – Page 83 states that the level of filtration should be 0.5 micron absolute, with no further qualification.
[100] A33103412 – SHTM 04-01 Part E, Aug 2015 – Bundle in relation to Water PPP – Page 676. The same provision can be found in the preceding guidance A46213604 - SHTN 2, Dec 1999 – Bundle in relation to Water PPP – Page 84.
[101] A33870103 – DMA L8 Risk Assessment, 1 May 2015 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 212.
[102] A44311388 - Part 1(ii) of GGC response to s.21 Notice 8 – Bundle in relation to Water PPP – Page 974.

Failure of filtration units

7.11. The reliability of the filtration units around the handover period is a potentially deficient feature. The specific concern was around periods offline, due to unreliability, creating a knock-on effect by preventing the tanks from being refilled as the water was used.

7.12. The 2015 DMA Report states:

> "There have been issues reported with filtration units failing leading to Bulk Water tanks draining down."[103] "Upon inspection DMA noted that water levels in Bulk Water Tanks 2A & 2B were extremely low. NHS Estates were informed and advised this was due to a fault on the filtration system which had led to the Raw Water supply to the tanks being shut down. As site estates staff do not currently have access to the BEMS system, they were unaware of this fault. DMA were later advised a similar fault had occurred on the other filtration set affecting Bulk Water Tanks 1A/1B. In order to ensure continuity of supply to all areas the bypass between 1A/1B and 2A/2B was opened on both occasions. DMA were advised Estates staff are unsure why the bypass is closed as all four Bulk Water Tanks were classified as linked. Until site staff have access to the BEMS and the filter system monitoring it may be advantageous to leave the bypass open, ensuring all tanks are balanced and to introduce an inspection/monitoring regime at suitable intervals."[104]

7.13. GGC have advised the Inquiry that the DMA Report refers to water levels in tanks 2A and 2B being low (and not 1A and 1B) and that GGC understood this is "what led to the by-pass being opened by the escorting Estates Manager who was with the assessors at that time. This action by the Estates Manager was recorded in documentation sent to the Sector Estates Manager on 9th April 2015."[105]

7.14. GGC have further advised: "The 2015 DMA Risk Assessment records verbal reports of issues with the filtration units. GGC have no record of faults or if there were faults, how and when they were resolved. No record of faults or repairs were given to GGC at handover."[106]

7.15. This unreliability of the filtration units is a potentially deficient feature for the purposes of Glasgow III.

[103] A33870103 – DMA L8 Risk Assessment, 1 May 2015 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 137.
[104] A33870103 – DMA L8 Risk Assessment, 1 May 2015 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 212.
[105] A40543960 - GGC response to RFI No 8 – Bundle in relation to Water PPP – Page 939.
[106] A40543960 - GGC response to RFI No 8 – Bundle in relation to Water PPP – Page 935.

Service records

7.16. The availability of records prompted a concern when the system was being audited for risks posed by legionella.. A Legionella Management and Compliance Audit of 4th May 2017 stated:

> "No chemical water treatment is being used on site. The water coming into the site goes through an ultra-filtration membrane process…The membrane filtration system service records were not available at the time of the audit."[107]

7.17. The auditors recommended for any service records of the filtration system to be added to the legionella records.

7.18. An GGC review dated 29 January 2019 of recommendations from reports on the water system advised that filter cleaning reports are now stored on the 'SGH shared drive'.[108]

7.19. This non availability of records is a potentially deficient feature for the purposes of Glasgow III.

Flushing

7.20. A concern arose that the system may have been flushed without using the filtration system, the risk being that items normally excluded by the filters would have been able to enter.

7.21. A Water Management Issues Technical Review produced by Health Facilities Scotland in March 2019 noted:

> "There is evidence that flushing took place without the main water system filters in place. These filters are designed to prevent organisms above 2μm entering the water supply".[109]

7.22. This is a potentially deficient feature for the purposes of Glasgow III

8. Pipework

8.1. In respect of the materials to be used for pipe work SHTM 04-01 advises:

> "The materials generally used for the conveyance of water in healthcare premises are stainless steel or plastics. Copper is only used in exceptional circumstances such as, an extension to existing premises

[107] A44312599 - Legionella Management and Compliance Audit – Bundle in relation to Water PPP – Page 1261.
[108] A33869445 – GGC Review of DMA Recommendations, 29 January 2019 – Bundle 8 for Oral hearing commencing 12 June 2023 – Page 88.
[109] A33448015 – HFS Water Management Issues Technical Review – Bundle for Oral Hearing Commencing 12 June 2023 – Bundle 7 - Page 145.

with short life expectancy, or very small stand alone premises."[110]

"Pipework in buildings should be designed and routed in a manner that will promote good turnover of water particularly in cold water service systems."[111]

"All cuttings of pipe should be capped immediately after they have been cut from a length of pipe and so also should the remainder of the length. If not, site supervisory staff should reject them from use on the system."[112]

"Temporary caps should be fitted to all open pipe ends of the pipework during installation, to protect it from ingress of dirt when it is not being worked on."[113]

Installation of pipework

8.2. It was observed in 2019 that methods around the time of installation of the pipework may have exposed it to a risk of contamination. In addition, a concern was raised that water may have been introduced to the pipework before commissioning, potentially for a prolonged period.

8.3. An NEC 3 Supervisor's report of March 2011 noted:

"Installation of hot, cold, heating and chilled water pipework on all levels is progressing, and generally being installed to a good standard. A few open ends were still being left for extended periods. Brookfield [Multiplex] to again be reminded to seal ends against ingress of dirt."[114]

8.4. It is not clear to the Inquiry team when this concern was first identified. This is the first explicit mention of open-ended pipework in the Supervisor's reports.

8.5. Open ended pipework was still being identified as a concern in the Supervisor's report of September 2013.[115] By April 2014 it was noted that there had been a marked improvement in all areas.[116] Installation of pipework was nearing completion in January 2015.[117]

[110] A32354164 - SHTM 04-01 Part A, July 2014 – Bundle in relation to Water PPP – Page 324. The same provision is in v1 of that guidance from August 2011 (archived July 2014).
[111] A32354164 - SHTM 04-01 Part A, July 2014 – Bundle in relation to Water PPP – Page 329. The same provision is in v1 of that guidance from August 2011 (archived July 2014).
[112] A33103412 – SHTM 04-01 Part E, Aug 2015 – Bundle in relation to Water PPP – Page 631; The same provision can be found in the preceding guidance A46213604 - SHTN 2, Dec 1999 – Bundle in relation to Water PPP – Page 28.
[113] A33103412 – SHTM 04-01 Part E, Aug 2015 – Bundle in relation to Water PPP – Page 631; The same provision can be found in the preceding guidance A46213604 - SHTN 2, Dec 1999 – Bundle in relation to Water PPP – Page 28.
[114] A33818735 - Capita Supervisor's Report No. 10 – Bundle in relation to Water PPP – Page 1031.
[115] A44312871 - Capita Supervisor's Report No. 30 – Bundle in relation to Water PPP – Page 1062.
[116] A44312885 – Capita Supervisor's Report No. 36 – Bundle in relation to Water PPP – Page 1107.
[117] A36384755 – Capita Supervisor's Report No. 45 – Bundle in relation to Water PPP – Page 1191.

8.6. In relation to this concern, a Water Management Issues Technical Review produced by HFS in March 2019 noted:

> "The Project Supervisor has noted in several reports that various pipes were left open-ended and unprotected during the installation period. There is no evidence to suggest that this pipe work was rejected, therefore the pipe work was probably subject to contamination and the introduction of moisture via condensation. There is evidence that water was in the pipe work in some areas of the building in August 2014. Commissioning of the systems was not until November 2014."[118]

8.7. The leaving open of pipework during and after installation is a potentially deficient feature for the purposes of Glasgow III.

Deadlegs of pipework and insufficient backflow protection

8.8. A potentially deficient feature of the water system related to the presence of 'deadlegs', this being where the pipework was set up or operated in such a way as to have lengths of pipe which did not see regular water flow. The potential risk was that the water may become stagnant, with potential for organic growth, not mitigated by regular flushing. Insufficient backflow protection on certain pipework was also noted as a potentially deficient feature, representing a risk that contaminated water might flow in a direction unintended by the purpose of the pipe.

8.9. DMA's 2015 Risk Assessment identified deadleg pipework in a number of areas of the hospital, including in plantrooms and a Medical Day Unit.[119] These were highlighted red for attention as soon as reasonably practicable.

8.10. A GGC review of DMA's recommendations dated 16 December 2018 considered that most of these were not deadlegs. For example, deadlegs noted by DMA in Hydrotherapy Plantroom A-1FMB-030 were described as "fill points for the drench shower/bib tap and are on a flushing regime".[120] More general deadlegs noted on the domestic water system were described as connections required for flushing purposes.[121] By contrast, deadleg pipework identified in Medical Day Unit MDU-005 was noted as having been removed on 24 July 2018.[122]

8.11. GGC have advised the Inquiry that the deadlegs identified by DMA were

[118] A33448015 – HFS Water Management Issues Technical Review – Bundle for Oral Hearing Commencing 12 June 2023 – Bundle 7 - Page 74.
[119] A33870103 – DMA L8 Risk Assessment, 1 May 2015 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Pages 156 and 163.
[120] A33872975 - GGC Review of DMA Recommendations, 16 December 2018 – Bundle in relation to Water PPP – Page 859.
[121] A33872975 - GGC Review of DMA Recommendations, 16 December 2018 – Bundle in relation to Water PPP – Page 852.
[122] A33872975 - GGC Review of DMA Recommendations, 16 December 2018 – Bundle in relation to Water PPP – Page 859.

removed between 2015 and 2017.[123] While the DMA Report of 25 April 2018 appears to identify much of the same deadleg pipework as in their 2015 report,[124] an GGC review of DMA's recommendations dated 29 January 2019 disagreed that these were deadlegs.[125]

8.12. Scottish Water Byelaws Inspection Reports of 28 February 2020 and 10 March 2023 identified numerous instances of high risk deadlegs and insufficient backflow protection across the QEUH site.[126] It is not known what remedial actions if any have been taken to address those concerns.

8.13. These identified deadlegs and lack of backflow protection are a potentially deficient feature for the purposes of Glasgow III.

Copper tails

8.14. Copper tails are lengths of pipe forming a connection between the main piping system and a fitting such as a tap. Their being made of copper, rather than the stainless steel specified for the water system, is contrary to the standards for materials to be used for pipe work in SHTM 04-01 discussed above.

8.15. DMA's 2015 report states:

> "there were copper tails on connections to a small number of outlets e.g. Infrared taps in non-patient toilets and in the endoscopy wash room DCT-009."[127]

8.16. SHTM 04-01 advises that corrosion of copper piping within DHCW [Domestic Hot and Cold Water] services in many Scottish hospitals and other Healthcare Premises is a serious problem."[128] As a result of the implications of the use of copper as a piping material, the SHTM recommends careful consideration prior to the material being proposed for use for DHCW services pipework in new or refurbishment projects. The strongest recommendation is made that it should be employed only for small, localised repairs.[129]

[123] A44311369 - Parts 1(iii), 1(iv) & 2(i) of GGC response to s.21 Notice 8 – Bundle in relation to Water PPP – Page 980.
[124] A33870243 – DMA Canyon L8 Risk Assessment, Final Submission 25 April 2018 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Pages 425 and 449.
[125] A33869445 – GGC Review of DMA Recommendations, 29 January 2019 – Bundle 8 for Oral hearing commencing 12 June 2023 – Pages 87 and 88.
[126] A43262538 - Scottish Water Byelaws Inspection Report, 28 February 2020 – Bundle in relation to Water PPP – Page 1390; A43262488 - Scottish Water Byelaws Inspection Report, 10 March 2023 – Bundle in relation to Water PPP – Page 1446.
[127] A33870103 – DMA L8 Risk Assessment, 1 May 2015 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 232.
[128] A33103412 – SHTM 04-01 Part E, Aug 2015 – Bundle in relation to Water PPP – Page 617; The same provision can be found in the preceding guidance A46213604 - SHTN 2, Dec 1999 – Bundle in relation to Water PPP – Page 13.
[129] A33103412 – SHTM 04-01 Part E, Aug 2015 – Bundle in relation to Water PPP – Page 618; A

8.17. The DMA Report of 25 April 2018 identifies the same concern regarding copper tails.[130] It is not clear to the Inquiry team what if any remedial action was taken to address this concern.

8.18. The existence of copper tails within the system is a potentially deficient feature for the purpose of Glasgow III.

Placement of pipework

8.19. The location of the pipework in the ceiling voids is a potentially deficient feature of the water system for the purposes of Glasgow III due to the relative difficulty of accessing such pipework as the location might make monitoring of the system more difficult.

8.20. DMA's 2015 report stated:

> "Domestic water pipework runs above ceilings throughout the building. Access for ongoing monitoring will be problematic as ceiling tiles cannot be easily removed within the hospital environment and alternative methods of monitoring should be considered should current BEMS [Building Energy Management System] monitoring points not be sufficient for the hot flow and return system (e.g. additional BEMS monitoring points installed)."[131]

8.21. The DMA report of 2018 identified the same concern.[132]

8.22. GGC reviewed the recommendations from DMA's 2015 and 2018 assessments on 16 December 2018 and 29 January 2019 respectively. It was noted in response to this concern:

> "This is a note, not a non-compliance…MEMS monitoring points are considered sufficient."[133]

Use of carbon steel pipework

8.23. One section of pipe was found to be made from 'carbon steel', a different material to the specified stainless steel. Multiplex have advised the Inquiry that:

similar provision can be found in the preceding guidance A46213604 - SHTN 2, Dec 1999 – Bundle in relation to Water PPP – Page 14.

[130] A33870243 – DMA Canyon L8 Risk Assessment, Final Submission 25 April 2018 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 426.

[131] A33870103 – DMA L8 Risk Assessment, 1 May 2015 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 232.

[132] A33870243 – DMA Canyon L8 Risk Assessment, Final Submission 25 April 2018 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 426.

[133] A33872975 - GGC Review of DMA Recommendations, 16 December 2018 – Bundle in relation to Water PPP – Pages 851 and 894; A33869445 – GGC Review of DMA Recommendations, 29 January 2019 – Bundle 8 for Oral hearing commencing 12 June 2023 – Pages 95, 96 and 102.

> "during April 2016 GGHB [Greater Glasgow Health Board] advised Multiplex that it had experienced a leak in the domestic water system in ARU2 [Acute Receiving Unit] and when repairing identified that a carbon steel fitting had been connected to the domestic water stainless steel pipework. Mercury carried out remediation of this."[134]

8.24. SHTM 04-01 advises:

> "The materials generally used for the conveyance of water in healthcare premises are stainless steel or plastics."[135] "The character of water in Scotland is such that steel, whether galvanised or not, should not be used at all for domestic hot and cold water installations. Any existing premises with such pipework shall have this scheduled for early replacement."[136] "Stainless steel, PVC-C, PB and PE-X piping may be used in hot water systems and in cold water systems."[137]

8.25. In response to this concern GGC have advised the Inquiry that the section of pipe was removed and a local disinfection undertaken.[138] Multiplex have advised that, during November 2016, Mercury and GGHB carried out a survey at random locations around the Hospital to confirm that this was an isolated incident. No carbon steel was identified during the survey.[139]

8.26. The use of carbon steel pipework in the water system is a potentially deficient feature for the purposes of Glasgow III.

Biofilm and corrosion

8.27. As part of an incident in 2018 a concern arose around exposed metal parts within sink waste pipes and the seal joining those pipes with plastic pipes. This potentially deficient feature arose from the fact that direct contact between metal and waste material was causing corrosion, with the join also forming a location where organic growth could occur.

8.28. IMT Minutes dated 8 June 2018 stated:

> "Colin Purdon showed the group an unused waste pipe that has been

[134] A44039957 - Multiplex Response to s.21 Notice number 8 – Bundle in relation to Water PPP – Page 1452.
[135] A32354164 - SHTM 04-01 Part A, July 2014 – Bundle in relation to Water PPP – Page 324. The same provision is in v1 of that guidance from August 2011 (archived July 2014).
[136] A32354164 - SHTM 04-01 Part A, July 2014 – Bundle in relation to Water PPP – Page 324. The same provision is in v1 of that guidance from August 2011 (archived July 2014).
[137] A33103412 – SHTM 04-01 Part E, Aug 2015 – Bundle in relation to Water PPP – Page 625; The same provision can be found in the preceding guidance A46213604 - SHTN 2, Dec 1999 – Bundle in relation to Water PPP – Page 22.
[138] A44311369 - Parts 1(iii), 1(iv) & 2(i) of GGC response to s.21 Notice 8 – Bundle in relation to Water PPP – Page 979.
[139] A44039957 - Multiplex Response to s.21 Notice number 8 – Bundle in relation to Water PPP – Page 1452. See also A44976432 - Domestic Water Service Survey – Bundle in relation to Water PPP – Page 999 and A44976593 - Domestic Water System Sample Schedule – Bundle in relation to Water PPP – Page 1219.

> fitted to all sinks within the RHC. It showed an exposed metal part of the pipe attached to a plastic pipe with a silicon seal around the join. Colin then produced a pipe that had been taken out of an existing CHWB [Clinical Hand Wash Basin] within a room in ward 2A which showed a thick bio film around the joint and inside the pipe as well as signs of corrosion to the metal.
>
> "Colin spoke about the pipe work and said the most recent version does not have exposed metal parts so no water/chemicals etc will be in contact with metal parts.
>
> "…Dr Inkster has proposed that all drains within high risk areas should be replaced with this updated version of pipe work."[140]

8.29. It appears from the IMT Minutes that this replacement work continued into late 2018, with a completion date set for 14 December of that year.[141]

8.30. This is a potentially deficient feature for the purposes of Glasgow III.

9. Plant rooms

9.1. The cleanliness of plant rooms was raised as a potentially deficient feature of the water system. IMT Minutes of 27 December 2018 stated:

> "all plant rooms checked, most plant rooms contained rubbish, food stuffs and bird droppings. Excessive in some. Plant room 12 – evidence of infestation with birds roosting on beams and pipes. Two live pigeons found."[142]

9.2. The same Minute advised that all plant rooms were cleaned and would be inspected every two weeks for evidence of pest infestations. The Inquiry team therefore understand this concern may be an ongoing one, dependent on appropriate operational procedures in order to be managed. It is not known if anything more has been done to help resolve the concern.

9.3. An IMT Minute of 14 August 2019 stated that a water sample taken from a basement plant room had tested positive for Klebsiella and Pseudomonas putida. It was not known if this was a pre or post filter sample.[143] It is not known what if any action was taken to resolve this concern.

9.4. A timeline of incidents produced by the GGC Oversight Board noted 'ongoing

[140] A36690464 – 08.06.2018 IMT – Bundle for Oral hearing commencing 12 June 2023 – Bundle 1 - Page 111.
[141] A36629319 – 22.11.2018 IMT – Bundle for Oral hearing commencing 12 June 2023 – Bundle 1 – Page 238.
[142] A36605180 – 27.12.2018 IMT – Bundle for Oral hearing commencing 12 June 2023 – Bundle 1 – Page 251.
[143] A36591626 – 14.08.2019 IMT – Bundle for Oral hearing commencing 12 June 2023 – Bundle 1 – Page 344.

issues' in August 2019 in the basement plant room in terms of yeast and mould that needed to be investigated further.[144] The same entry on the timeline notes that water samples from the main water tank room tested positive for Pseudomonas and coliforms, as well as for mould and yeast. It is also not known what if any action was taken to resolve this concern.

9.5. The cleanliness of plant rooms is a potentially deficient feature for the purposes of Glasgow III.

10. Cold water distribution supply, cold water dump valves, layout of hot/cold pipes

10.1. SHTM 04-01 states:

> "The [cold water distribution] installation should be designed to avoid waste, undue consumption, misuse and contamination. Every water fitting through which water is supplied for domestic purposes should be installed in such a manner that no backflow of fluid from any appliance, fitting or process can take place"[145]
>
> "All pipework should be insulated, except for any exposed final connections to sanitary appliances, and should be arranged to eliminate or minimise dead-legs."[146]
>
> "The control of water temperature in the cold water service, however, will essentially rely on good insulation and water turnover. Cold water services should be sized to provide sufficient flow at draw-off points. Stagnation should be avoided."[147]

Single Cold Water Supply

10.2. The fact that, in general, all units were supplied by the single bulk water system is a potentially deficient feature of the water system at QEUH. The concern is that this lack of flexibility created a risk when it came to functions such as disinfecting the system, such that co-ordination would be required to ensure that this be done at suitable times.

10.3. DMA's report of 2015 stated:

> "It should be noted that there is no separate dedicated supply to the

[144] A33448013 – Oversight Board Infection Timeline - Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 966.
[145] A32354164 - SHTM 04-01 Part A, July 2014 – Bundle in relation to Water PPP – Page 294. The same provision is in v1 of that guidance from August 2011 (archived July 2014).
[146] A32354164 - SHTM 04-01 Part A, July 2014 – Bundle in relation to Water PPP – Page 295. The same provision is in v1 of that guidance from August 2011 (archived July 2014).
[147] A32354164 - SHTM 04-01 Part A, July 2014 – Bundle in relation to Water PPP – Page 295. The same provision is in v1 of that guidance from August 2011 (archived July 2014).

> Renal (or other medical) systems, with all being fed from the Bulk Water system. This means that system disinfections will require to be very carefully scheduled or carried out locally as the disinfection procedure/chemical may interfere with the renal/medical systems and impact on patient welfare."[148]

10.4. The Inquiry team understand that the nature of this concern is an ongoing one, dependent on appropriate operational procedures in order to be managed. DMA's report of 2018 recommended:

> "an emergency action plan is formulated to allow for system disinfection if/when required and this should include alternative supplies to Renal (or other) medical systems, or alternative arrangements made for the period disinfection is being carried out."[149]

10.5. A report produced by DMA in January 2019 noted:

> "DMA understands that suitable filtration and testing regimes have been implemented on the renal system in light of the ClO_2 [Chlorine Dioxide] dosing systems being installed, and that supply pipework to the renal plants have been altered to bypass the local ClO_2 'top-up' units. Emergency procedures should be considered and formulated to allow for system disinfection if required. Alternatively, a separate independent supply should be considered for this system."[150]

10.6. It is not clear what further remedial actions have been taken for this concern.

10.7. This single point of supply system is a potentially deficient feature for the purposes of Glasgow III.

Cold Water Temperature

10.8. Variations in the temperature in the cold-water system were raised persistently as a potentially deficient feature of the system. Higher temperatures create a greater risk of organic contamination, that being of particular concern with regard to legionella.

10.9. DMA advised in their 2015 report:

> "The cold water temperatures recorded by DMA vary considerably with the majority being more than 5°C higher than those recorded at the water tanks and with peak temperatures of 30°C being noted. Additional control measure such as flushing, disinfections and background dosing flushing should be implemented until such times as the area/department

[148] A33870103 – DMA L8 Risk Assessment, 1 May 2015 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 231.
[149] A33870243 – DMA Canyon L8 Risk Assessment, Final Submission 25 April 2018 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 421.
[150] A33870454 - DMA Canyon Water System Risk Assessment, January 2019 – Bundle in relation to Water PPP – Page 1371.

> fully occupied, storage and distribution temperatures and microbiological results are consistently satisfactory."[151]

10.10. SHTM 04-01 recommends that, in normal circumstances, cold water should be delivered below 20°C. Anything above 20°C creates the potential for Legionella bacteria to breed. At cold water draw-off points, a temperature of no greater than 2°C above the temperature measured in cistern and cold-water header tanks should be reached within two minutes.[152]

10.11. Due to the temperature deviations and out of specification NHS microbiological sampling results, DMA recommended fitting supplementary control systems (e.g. background dosing such as chlorine dioxide), in order to maintain microbiological control and/or biofilm monitors (such as BioSense sensors/controller) to assist in focusing remedial actions onto identified areas of microbial activity.[153]

10.12. Heat gain on the cold-water system was recorded again by DMA in both their 2018 and 2019 reports:

> "Investigations should be carried out as to the reasons for this with appropriate remedial actions taken e.g. additional insulation, installation of flushing valves, manual flushing of outlets, servicing of TMVs to reduce likelihood of back flow of hot into cold (or opposite). Sampling, disinfections and background dosing should be considered as part of the escalation process should any issues persist."[154]

10.13. GGC reviewed the recommendations from DMA's 2015 and 2018 assessments on 16 December 2018 and 29 January 2019 respectively. It was noted in response to this concern:

> "Temperature issues were due to lack of occupancy on the site and has subsequently been resolved around full occupancy. Each sector/ward area had a robust flushing and sampling regime carried out prior to occupancy by clinical staff/patients etc."[155]

> "This is a note - not a non-compliance. Set point increase on calorifiers [noted as having a possible beneficial effect of improving cold water

[151] A33870103 – DMA L8 Risk Assessment, 1 May 2015 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 231.
[152] A32354164 - SHTM 04-01 Part A, July 2014 – Bundle in relation to Water PPP – Page 295. The same provision is in v1 of that guidance from August 2011 (archived July 2014).
[153] A33870103 – DMA L8 Risk Assessment, 1 May 2015 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 231.
[154] A33870243 – DMA Canyon L8 Risk Assessment, Final Submission 25 April 2018 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 425; A33870454 - DMA Canyon Water System Risk Assessment, January 2019 – Bundle in relation to Water PPP – Page 1373.
[155] A33872975 - GGC Review of DMA Recommendations, 16 December 2018 – Bundle in relation to Water PPP – Page 850.

temperature] was done in 2015."[156]

10.14. The full extent of remedial actions undertaken is not known to the Inquiry team. GGC have advised the Inquiry that from November 2018 to January 2019, a Continuous Chlorine Dioxide dosing system was installed in the QEUH and RHC.[157] It is not known if this fixed the concern or whether it was done in response to either of the DMA reports or the findings of the 2018 Water Incident IMT.

10.15. In any event the variations of the temperature of the cold-water system is a potentially deficient feature for the purposes for Glasgow III.

Dump Valves in the cold-water system

10.16. The presence of dump valves might serve to mitigate concern about variations of the temperature of the cold-water system by causing automatic flushing should the cold water reach a particular temperature. However, a concern was raised as to whether those were functioning properly. The dump valves may therefore themselves have constituted a potentially deficient feature. The consequent risk would be of the higher temperatures going unaddressed.

10.17. DMA's 2015 report stated:

> "there are ongoing commissioning problems on the cold water dump valve system and the system is not operating as intended. DMA have noted during site surveys there were areas with cold water temperatures in excess of 20°C and dump valves are fitted, but the valves not discharging. Corrective action should be taken and once fully operational the control set points and parameters for discharging should be referenced in site written scheme."[158]

10.18. The Inquiry team understand that dump valves reduce the ability for water to stagnate, by purging it automatically from the cold-water distribution system. At QEUH, the dump valves were intended to purge water when the building management system detected cold water temperatures of 23°C.

10.19. GGC reviewed the recommendations from DMA's 2015 assessment on 16 December 2018. It was noted in response to this concern:

> "Dump valves were not fully operating at this time since they had been installed without the valve heads connected correctly. New Draft written scheme has been amended. Flushing occurred for 12 week

[156] A33869445 – GGC Review of DMA Recommendations, 29 January 2019 – Bundle 8 for Oral hearing commencing 12 June 2023 – Page 95.
[157] A44311369 - Parts 1(iii), 1(iv) & 2(i) of GGC response to s.21 Notice 8 – Bundle in relation to Water PPP – Page 984.
[158] A33870103 – DMA L8 Risk Assessment, 1 May 2015 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 231.

commissioning period."[159]

10.20. GGC have advised that, after April/May 2015, cold water dump valve heads were connected to BMS system to rectify this concern.[160] The dump valve system was not mentioned in DMA's 2018 or 2019 report. Accordingly, the Inquiry team understand that the above actions resolved the concern.

10.21. The non-operation of the dump values in the first few months of occupation of the hospital is a potentially deficient feature of the system for the purposes of Glasgow III.

Steam humidifiers

10.22. Steam humidifiers were present on the system for a time without being operational, and as such were identified as a potentially deficient feature of the water system. The consequence (as might be the case for any unused equipment) was of its mere presence constituting a deadleg, there being as a result a length of 'pipe' which would not see throughflow of water.

10.23. DMA advised in their 2015 report:

> "The steam humidifiers do not appear to have been commissioned as yet (and DMA were informed by Estates these may not actually be commissioned in the immediate future) creating deadlegs on the cold system within the relevant plantrooms. It is advised that these have suitable backflow protection installed on the lines where the tee-off from the main line or are included in the site flushing regime until such times as the units are commissioned and fully operational."[161]

10.24. In response to this concern GGC have advised that the steam humidifiers referred to were removed in February 2018.[162] Steam humidifiers were not raised as a concern in DMA's 2018 report. Accordingly the Inquiry team understand this action resolved the concern.

10.25. The non-commissioning of the steam humidifiers in the first few months of occupation of the hospital is a potentially deficient feature of the system for the purposes of Glasgow III.

Pipework runs and sentinel outlets

10.26. In 2015 it was identified that in some places the configuration of the pipework

[159] A33872975 - GGC Review of DMA Recommendations, 16 December 2018 – Bundle in relation to Water PPP – Page 851.
[160] A44311369 - Parts 1(iii), 1(iv) & 2(i) of GGC response to s.21 Notice 8 – Bundle in relation to Water PPP – Page 979.
[161] A33870103 – DMA L8 Risk Assessment, 1 May 2015 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 233.
[162] A44311369 - Parts 1(iii), 1(iv) & 2(i) of GGC response to s.21 Notice 8 – Bundle in relation to Water PPP – Page 981.

meant that long sections of pipe existed which might see little flow of water, creating a risk of stagnancy if flushing did not otherwise take place. DMA's 2015 report stated:

> "The bib taps, irrigation points etc. and 12th floor heli-pad fire suppression system which are fed from the Trades system have very long runs through the building and plantrooms to the outlets. All points on the trades system should be included in the site flushing regime – though additional flushing (outlets run for extended periods) may be required to bring temperatures on distribution system down particularly during periods of low use (e.g. in winter when irrigation system is not required to operate frequently).
>
> "No outlets on the Trades system have been designated as 'sentinel outlets'. Due to the type of system and the extended pipe runs to the outlets it may be prudent to designate all outlets from this system as sentinel and include in monthly monitoring and site flushing regime."[163]

10.27. The same concern is flagged in DMA's 2018 and 2019 reports.[164] The 2019 report notes that irrigation points are no longer connected to the water system, but still recommends inclusion of all points on the Trades system in the site flushing regime. DMA also note in their 2019 report that a programme of removing all non-essential bib taps and outlets on the Trades system is under way. The meaning and significance of sentinel outlets are not clear to the Inquiry team. It is also not clear what if any remedial action has been taken in relation to the recommendation for sentinel outlets on the Trades system.

10.28. GGC reviewed the recommendations from DMA's 2015 and 2018 assessments on 16 December 2018 and 29 January 2019 respectively.[165] In response to DMA's concern it was noted that the irrigation system was disconnected in early 2017 and that the Trade system only supplied the fire-fighting equipment for the helipad. Flushing was not considered to be required.[166] It is not yet clear to the Inquiry team how this sits with DMA's recommendation for flushing.

10.29. The parts of the trades system identified in the 2015 DMA report and described above are potentially deficient features for the purposes of Glasgow III.

[163] A33870103 – DMA L8 Risk Assessment, 1 May 2015 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 233.
[164] A33870243 – DMA Canyon L8 Risk Assessment, Final Submission 25 April 2018 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 427; A33870454 - DMA Canyon Water System Risk Assessment, January 2019 – Bundle in relation to Water PPP – Page 1375.
[165] A33872975 - GGC Review of DMA Recommendations, 16 December 2018 – Bundle in relation to Water PPP – Page 844; A33869445 – GGC Review of DMA Recommendations, 29 January 2019 – Bundle 8 for Oral hearing commencing 12 June 2023 – Page 86.
[166] A33872975 - GGC Review of DMA Recommendations, 16 December 2018 – Bundle in relation to Water PPP – Page 860.

Out of specification sampling results

10.30. The 2015 DMA report stated:

> "A microbiological sampling sweep was being undertaken whilst DMA were on site carrying out the site surveys. No results for these samples have been forwarded to DMA for comment or recommendations, though DMA were advised that system disinfections were being carried out on 24th April due to 'out-of-specification' results being returned and that an increased flushing regime had been implemented in the areas where out of specifications results obtained."[167]

10.31. The Inquiry team understand 'out of specification' to mean water samples where particular microbe levels are exceeded. In such an event escalation procedures and remedial actions are recommended.

10.32. As discussed at paragraphs 10.8 to 10.14 of this Note, the out of specification sampling results in conjunction with temperature deviation led DMA to recommend fitting supplementary control systems (e.g. background dosing such as chlorine dioxide), in order to maintain microbiological control and/or biofilm monitors (such as BioSense sensors/controller) to assist in focusing remedial actions onto identified areas of microbial activity.[168]

10.33. GGC have advised the Inquiry team that the water systems were re-sterilised in late April/May 2015 as a result of these failed samples.[169] However in light of the later contamination concerns discussed elsewhere in this PPP, the Inquiry team's current understanding is that this re-sterilisation did not resolve the presence of microbes in the hospital's water system. GGC have advised the Inquiry that from November 2018 to January 2019, a Continuous Chlorine Dioxide dosing system was installed in the QEUH and RHC.[170] It is not known if this fixed the concern.

10.34. That the cold water system was out of specification is a potentially deficient features for the purposes of Glasgow III.

11. Hot water distribution supply

11.1. SHTM 04-01 states that:

> "Hot water is taken from the top of the storage vessel, or water heater,

[167] A33870103 – DMA L8 Risk Assessment, 1 May 2015 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 233.
[168] A33870103 – DMA L8 Risk Assessment, 1 May 2015 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 231.
[169] A44311369 - Parts 1(iii), 1(iv) & 2(i) of GGC response to s.21 Notice 8 – Bundle in relation to Water PPP – Page 979.
[170] A44311369 - Parts 1(iii), 1(iv) & 2(i) of GGC response to s.21 Notice 8 – Bundle in relation to Water PPP – Page 984.

> and will normally be circulated around the building in a piped distribution system. The flow temperature should be set to 60°C and the minimum temperature of all return legs to the vessel or water heater should be 50°C… The individual outlets, taps, mixing valves or other outlet devices will be served from the distribution system; this should be designed such that the minimum temperature at the most distant taps or outlets is 55°C. The control of Legionella requires there to be a minimum temperature of 50°C in hot water service systems."[171]

Water temperature

11.2. Concern was raised in 2015 that temperatures in the hot water system being below that recommended by guidance. DMA's 2015 report stated:

> "hot [water] temperatures frequently recorded below 55°C at supply to TMVs. It should be noted though that direct hot taps did reach temperatures of 55°C and supply to TMVs was almost invariably above 50°C... As 55°C at all outlets is the control parameter set by SHTM 04-01 corrective actions should be carried out to ensure this is achieved. This may include increasing the calorifier set points - see calorifier sections for further comments and recommendations."[172]

11.3. Calorifiers are dealt with separately at Chapter 12 of this Note.

11.4. GGC have advised the Inquiry that the temperatures of calorifiers were increased from 60°C to 65°C in May 2015 to resolve the low temperatures identified by DMA.[173]

11.5. DMA's 2018 and 2019 reports suggests an improvement in hot water temperatures, describing them as "generally satisfactory".[174] However an HFS Water Management review of March 2019 noted:

> "The hot water is designed for 60°C flow and 55°C return. It has been advised by GGC that these temperatures are not what is being found in practice due to issues with the Energy Centre."[175]

11.6. Pro Lp Consulting Ltd's Authorising Engineer Management and Compliance Audit dated 28 February and 1 March 2022 advised:

> "The calorifier flow and return temperatures generally appear to be

[171] A32354164 - SHTM 04-01 Part A, July 2014 – Bundle in relation to Water PPP – Page 308. The same provision is in v1 of that guidance from August 2011 (archived July 2014).
[172] A33870103 – DMA L8 Risk Assessment, 1 May 2015 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 231.
[173] A44311369 - Parts 1(iii), 1(iv) & 2(i) of GGC response to s.21 Notice 8 – Bundle in relation to Water PPP – Page 979.
[174] A33870243 – DMA Canyon L8 Risk Assessment, Final Submission 25 April 2018 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 425; A33870454 - DMA Canyon Water System Risk Assessment, January 2019 – Bundle in relation to Water PPP – Page 1373.
[175] A33448015 – HFS Water Management Issues Technical Review – Bundle for Oral Hearing Commencing 12 June 2023 – Bundle 7 - Page 82.

acceptable. They are monitored on the monthly sheets and also on the Scheider BMS."[176]

11.7. It is not clear to the Inquiry team whether the concern regarding hot water temperature has therefore been resolved and therefore the hot water system temperature is a potentially deficient feature for the purposes of Glasgow III.

Deadlegs in the hot water system

11.8. The set-up of the hot water system is identified as a potentially deficient feature, in that its configuration led to the existence of (at least potential) deadlegs. Again, the risk from a deadleg would be from the potential for stagnant water to build up unless flow arose from use or from flushing.

11.9. DMA's 2015 report stated:

> "DMA have been advised by Mercury Engineering that the domestic hot water systems do not operate on a conventional flow and return system, with principle, sub-ordinate and tertiary loops, instead utilising a reverse return circuit. This means that there are longer 'deadlegs' to the outlets than SHTM 04-01 advises."[177]

11.10. DMA's 2018 report stated:

> "At the time of initial assessment in 2015 DMA were advised that there are minimal localised "tertiary" loops and that the drops to individual outlets were as short as was reasonably practical to install. It was noted that hot temperatures generally rose very quickly when DMA were recording temperatures throughout the building and the flow and return circuits appear to be circulating hot water in most areas."[178]

11.11. DMA's January 2019 report advised that alterations had been made to the hot flow and return system in Wards 2A & 2B to bring the flow and return loops down as close as practical to the actual outlets, though those wards remained out of use at the time of the report.[179] It is not clear to the Inquiry team whether this means the concern has been resolved. The existence of such deadlegs is therefore a potentially deficient feature for the purposes of Glasgow III.

[176] A44312654 - Pro Lp Consulting Ltd Audit 2022 – Bundle in relation to Water PPP – Page 1414.
[177] A33870103 – DMA L8 Risk Assessment, 1 May 2015 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 232.
[178] A33870243 – DMA Canyon L8 Risk Assessment, Final Submission 25 April 2018 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 425.
[179] A33870454 - DMA Canyon Water System Risk Assessment, January 2019 – Bundle in relation to Water PPP – Page 1373.

12. Calorifiers

12.1. SHTM 04-01 explains:

> "Storage calorifiers are usually cylindrical vessels mounted either vertically or horizontally…the entire storage volume should be capable of being heated to 60°C without permanent pockets of lukewarm water."[180]

> "Where more than one calorifier or heating device is used, they should be connected in parallel, taking care to ensure that the flow can be balanced so that the water temperature from all the calorifiers is not less than 60°C at all times."[181]

Temperature

12.2. A concern has been repeatedly raised about the temperature of hot water. Too low a temperature creates the risk potential for growth of certain microorganisms. The remedial measures for this included addressing the output of the calorifiers.

12.3. DMA's report of 2015 advised:

> "The return temperatures recorded at the calorifiers were consistently below 55°C which DMA were advised was the control set point for these, though when calorifiers were at full temperature the returns were reaching 50°C. It may be prudent to increase calorifier set points to ensure calorifier returns remain above 55°C as this is the control set point. This may also help maintain a 60C minimum flow temperature when demand is placed on the calorifiers as the building becomes occupied. Increasing the calorifier temperatures may also have the beneficial effect of increasing the cold water usage as more cold water will be required at TMVs to blend water to TMV set point and so may assist in reducing the high cold water temperatures being recorded within the system.

> "When DMA were on site on the 21st of April there was a significant drop on the temperatures of the calorifiers 31-01/02/03, 31-07/08/09 and 21-01/02/03 which we understand was caused by a failure on the heating system. Temperatures recorded on these calorifiers on this day (as recorded in the following sheets) was 40- 45°C. This represented a significant break in the control system and there were no records of any remedial or corrective actions and no records of additional control measures. DMA would advise corrective actions and additional control measures (e.g. system pasteurisation/disinfection) should be carried out

[180] A32354164 - SHTM 04-01 Part A, July 2014 – Bundle in relation to Water PPP – Page 311. The same provision is in v1 of that guidance from August 2011 (archived July 2014).
[181] A32354164 - SHTM 04-01 Part A, July 2014 – Bundle in relation to Water PPP – Page 312. The same provision is in v1 of that guidance from August 2011 (archived July 2014).

in accordance with SHTM 04-01 in instances of this type. When DMA re-checked the affected calorifier temperatures on 27th April 2015 the temperatures had improved though 31-07/08/09 were still significantly lower than expected.

When calorifiers are running at full temperature they appear to be achieving 60°C consistently, though this cannot be fully verified as estates staff did not have full access to the BEMS system at the time of survey. There have been some exceptions to this as highlighted in the supportive data following where one calorifier appears to be the lead calorifier and subsequently has lower temperatures than the connected calorifiers in the bank of 3. This may be a balancing issue and should be investigated and corrected (e.g. Calorifiers 22- 01/02/03 with 02 being significantly lower temperature than 01 & 03)."[182]

12.4. GGC have advised the Inquiry that the temperatures of calorifiers were increased from 60°C to 65°C in May 2015 to resolve the low temperatures identified by DMA.[183] However DMA's 2018 report noted the same concern with respect to calorifier return temperatures and temperature discrepancies between lead and connected calorifiers in banks of three.[184]

12.5. DMA's report of January 2019 advised

"whilst carrying out flushing works and ClO_2 testing in wards 2A & 2B during December 2018 there were multiple instances of hot temperatures dropping off and being recorded at <55°C. This was reported to Estates on each occasion, with DMA advised there were issues in the Energy Centre which were causing a reduction in the MTHW supply to the Adult & Children's Hospital, which had a knock on effect to the calorifiers. Generally when advised issues were rectified the temperatures recovered quickly to ≥60°C within the wards.

"Distribution flow temperatures were consistently above 60°C, with return temperatures to calorifiers consistently above 55°C on all calorifiers (Plantroom 21 calorifiers just above 55°C), as recommended within L8/HSG 274 Part 2 and SHTM 04-01. All base temperature appeared satisfactory at time of survey also (26/09/18)"[185]

12.6. These repeated concerns about water temperatures in the hot water system is a potentially deficient feature for the purposes of Glasgow III.

[182] A33870103 – DMA L8 Risk Assessment, 1 May 2015 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 219.
[183] A44311369 - Parts 1(iii), 1(iv) & 2(i) of GGC response to s.21 Notice 8 – Bundle in relation to Water PPP – Page 979.
[184] A33870243 – DMA Canyon L8 Risk Assessment, Final Submission 25 April 2018 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 424.
[185] A33870454 - DMA Canyon Water System Risk Assessment, January 2019 – Bundle in relation to Water PPP – Page 1372.

Non-operational Calorifiers as Deadlegs

12.7. One concern arising from the calorifiers related to a period when one was observed not to be in operation, with the result that it itself effectively came to form a deadleg because water was no longer flowing through it.

12.8. DMA's 2015 report advised:

> "Calorifier 32-03 was offline when DMA had an initial site familiarisation walk-round with Mercury Engineering in early January 2015. This calorifier was still offline when DMA were on site on 21st April 2015. This was creating deadlegs on the cold supply, hot flow and hot return to the calorifier and Estates staff were unable to confirm the reason for this calorifier being offline. This calorifier had been reinstated when DMA revisited on 27/04/15 though Estates not aware of any flushing, pasteurisation or disinfection of calorifier being carried out prior to reinstatement. DMA would recommend the calorifier (and hot system) is disinfected/pasteurised legionella samples taken from the calorifier and system prior to reinstatement to confirm these corrective actions have been effective."[186]

12.9. The above concern was not mentioned in DMA's 2018 or 2019 reports. The Inquiry team therefore presume the concern was resolved, however it is not clear what remedial action was taken to affect this.

12.10. The 2015 and 2018 DMA reports noted a deadleg to calorifiers in plant room 33.[187] An GGC review of this recommendation dated 16 December 2018 advised that no such deadleg was identified.[188]

12.11. Whether calorifiers have acted as deadlegs is a potentially deficient feature of the water system for the purposes of Glasgow III

Flushing

12.12. In 2015 concern was raised regarding the extent to which the calorifiers were flushed. Insufficient flushing would create the potential for the calorifiers to be locations where contamination could accumulate. DMA's 2018 report advised:

> "DMA noted very dirty water was purged from a number of calorifier drains which may indicate the flushing regime should be increased (Estates advised during the Gap Analysis that base flushing is being carried out though were unable to provide supporting evidence), or that

[186] A33870103 – DMA L8 Risk Assessment, 1 May 2015 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 219.
[187] A33870103 – DMA L8 Risk Assessment, 1 May 2015 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 226; A33870243 – DMA Canyon L8 Risk Assessment, Final Submission 25 April 2018 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 482.
[188] A33872975 - GGC Review of DMA Recommendations, 16 December 2018 – Bundle in relation to Water PPP – Page 849.

> the methodology for flushing should be reviewed to ensure the calorifier base is being purged and not just the supply pipework."[189]

12.13. An GGC review of this recommendation dated 29 January 2019 noted:

> "The blowdown of all calorifiers and expansion vessels is carried out on a monthly basis at present."[190]

12.14. DMA's report of January 2019 advised:

> "Generally water flushed from drain on calorifiers and expansion vessels ran clear either instantly or after only a very short period of time (typically <10 seconds)."[191]

12.15. For the period before the commencement of regular blowdown or flushing of the calorifiers and expansion vessels insufficient flushing would be a potentially deficient feature of the water system.

13. Expansion vessels

13.1. The expansion vessels were identified as a potentially deficient feature of the water system. A concern was raised regarding the design of them created a risk of them (or at least areas within them) acting as 'deadlegs' such that they were not being reliably flushed, with the result being a risk that contamination could accumulate.

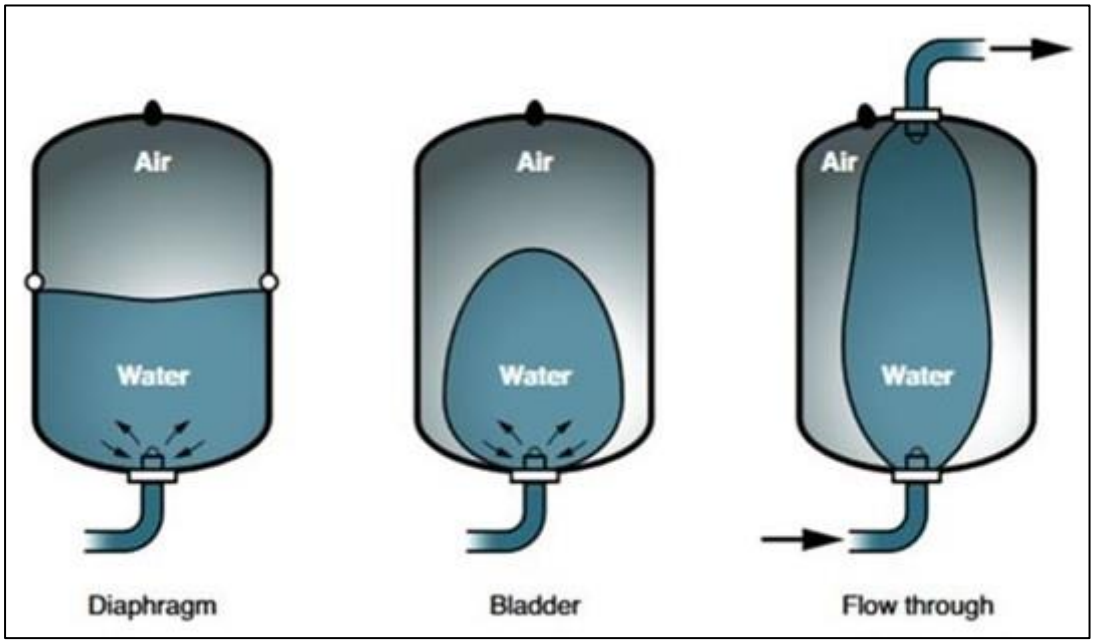
13.2. SHTM 04-01 sets out a description of the typical format of such vessels, as well as indicating the potential for unsafe features to arise:

> "The expansion vessels forming part of the pumping sets are typically pressurisation vessels, are typically vertical in orientation and have either a diaphragm or nitrogen fill in the upper space. They introduce a potential problem of colonisation by Legionella, as the plantroom space temperature will exceed that of the incoming water. They should be preferably of a design such that water flows through the vessel, entering at low level, and discharging at a higher level below the water line. Interconnecting pipework should be kept to a minimum, and the vessel should be insulated to minimise heat gain. All materials in contact with water should be WRAS-approved. It is important that the expansion vessel is located on the cold feed rather than on the hot water side of the system."[192]

[189] A33870243 – DMA Canyon L8 Risk Assessment, Final Submission 25 April 2018 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 424.
[190] A33869445 – GGC Review of DMA Recommendations, 29 January 2019 – Bundle 8 for Oral hearing commencing 12 June 2023 – Page 91.
[191] A33870454 - DMA Canyon Water System Risk Assessment, January 2019 – Bundle in relation to Water PPP – Page 1372.
[192] A32354164 - SHTM 04-01 Part A, July 2014 – Bundle in relation to Water PPP – Page 315. The same provision is in v1 of that guidance from August 2011 (archived July 2014).

13.3. HSE guidance on Legionnaire's Disease illustrates common designs for expansion vessels, including the directions of water flow, and describes further the risk of certain materials providing a surface location for contamination:

> "…In pressurised systems, a means of accommodating water expansion (caused by the water heating) is required. This is often achieved with the use of an expansion vessel. However, these may not fill and empty where the system pressure and temperature remains steady….



13.4. These internal bladders are often made of synthetic rubber such as EPDM and may support the growth of microorganisms. Vessels with a 'flow through' design should provide less opportunity for water to stagnate and become contaminated (as in the latter design)."[193]

13.5. DMA Canyon, in their Risk Assessment dated 25 April 2017, raised a concern regarding the design of expansion vessels, indicating that they were not of the 'flow through' type recommended in the passages above, and raised the possibility that the vessels had not received servicing:

> "Wherever possible/practical expansion vessels should be 'flow through' vessels and suitably insulated. Where this is not possible a expansion vessel should be included in site flushing regime (to correct procedure). Estates advised during the Gap Analysis that no expansion vessel flushing is being carried out and we would advise this is started immediately in addition to any servicing of the vessel which may also

[193] A46126597 - HSG274 Part 2 – Bundle in relation to Water PPP – Page 209.

have been missed previously”[194]

13.6. DMA’s Water System Risk Assessment dated January 2019 repeated the above concern, while noting that remedial work was to be undertaken, as well as recording improved results in a flushing test from that carried out for the 2018 DMA report (set out above at the section on ‘calorifiers – flushing’):

> “The expansion vessels attached to the calorifiers are not of a flow through design as recommended in HSG 274 Part 2 (info Box 2.1) and SHTM 04-01 Part A (Para 8.22) and they are not insulated as recommended in SHTM 04-01 Part A (Para 8.22). Estates advised that there is an intention to alter the pipework and vessels to accommodate flow through vessels in early 2019. Generally water flushed from drain on calorifiers and expansion vessels ran clear either instantly or after only a very short period of time (typically less than 10 seconds). No internal records of inspection for calorifiers were available” [195]

13.7. GGC have indicated to the Inquiry that work to address the above issue took place in February/March 2019:

> “Feb/Mar 2019
>
> 1(iii): Material change made to the water system (whether the physical infrastructure or system or working) as a result of concerns about its safety
>
> Replacement of 24 Domestic Hot Water expansion vessels (all plantrooms)
>
> (iv) Succinct explanation why material change was made
>
> Recommendation of 2017 DMA Risk Assessment (received in April 2018). The new design would be a flow through to remove the need for flushing the drains on the expansion vessels as this is deemed a dead leg”[196]

13.8. GGC have also indicated to the Inquiry that, as at May 2023, work was ongoing to replace domestic hot water expansion vessels as those had reached the end of their life cycles, but is not understood to have been a response to any wider concern.[197]

13.9. The use of non-flow through expansion vessels is a potentially deficient

[194] A33870243 – DMA Canyon L8 Risk Assessment, Final Submission 25 April 2018 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 435.
[195] A33870454 - DMA Canyon Water System Risk Assessment, January 2019 – Bundle in relation to Water PPP – Page 1372.
[196] A44311444 - Parts 2(i), (ii) and (iii) of GGC response to s.21 Notice 8 – Bundle in relation to Water PPP – Page 985.
[197] A44311369 - Parts 1(iii), 1(iv) & 2(i) of GGC response to s.21 Notice 8 – Bundle in relation to Water PPP – Page 987.

feature of the water system for the purposes of Glasgow III.

14. Chilled Beam Units ("CBUs")

14.1. The Inquiry team understand the chilled beam system is a separate water system designed supply water to the CBUs to control the cooling and heating within patient rooms.[198]

14.2. An IMT Minute of 19 June 2019 raised a concern of leaks from CBUs due to a boiler failure.[199] A later IMT of 1 August 2019 questioned why patients were situated underneath CBUs when there was a risk of condensation and/or leaking water dripping onto them. It was also noted that all patient rooms within the QEUH (with the exception of Ward 4B BMT) and RHC had CBUs.[200]

14.3. The merits of CBUs in hospitals, the existence of guidance on their use and their presence in the various wards in the hospital is discussed in the PPP on the Potentially Deficient Features of the ventilation system of the QEUH/RHC and reference is made to that document.

14.4. The IMT Minute of 1 August 2019 advised that sample fluid was taken from the chilled beams and tested for the presence of gram negative organisms.[201] 4 water samples (2 hot and 2 cold) were taken. The two hot water samples came back negative. The two cold water samples came back with heavy growth of pseudomonas oleovorans and small numbers of aeruginosa.[202]

14.5. It was agreed the CBUs would be cleaned every six weeks instead of the three month regime in place at that time.[203] New mechanical connectors to replace leaking fittings and biocide dosing were introduced in late August/early September 2019.[204]

14.6. Since the introduction of biocide to the cold water system of the chilled beams water samples were negative/clear.[205] The Inquiry team therefore understand

[198] A37991876 – 01.08.2019 IMT – Bundle for Oral hearing commencing 12 June 2023 – Bundle 1 – Page 335.
[199] A36591625 – 19.06.2019 IMT – Bundle for Oral hearing commencing 12 June 2023 – Bundle 1 Page 323.
[200] A37991876 – 01.08.2019 IMT – Bundle for Oral hearing commencing 12 June 2023 – Bundle 1 – Page 335.
[201] A37991876 – 01.08.2019 IMT – Bundle for Oral hearing commencing 12 June 2023 – Bundle 1 – Page 335.
[202] A37991958 – 08.08.2019 IMT – Bundle for Oral hearing commencing 12 June 2023 – Bundle 1– Page 339.
[203] A37991876 – 01.08.2019 IMT – Bundle for Oral hearing commencing 12 June 2023 – Bundle 1 – Page 336.
[204] A41890723 – 23.08.2019 IMT – Bundle for Oral hearing commencing 12 June 2023 – Bundle 1 – Page 351.
[205] A36591627 – 13.09.2019 IMT – Bundle for Oral hearing commencing 12 June 2023 – Bundle 1 – Page 361.

this concern was resolved.

14.7. However the use of CBUs in the hospital is a potentially deficient feature for the purposes of Glasgow III.

15. Metering, temperature control, monitoring

15.1. SHTM 04-01 provides:

> "Domestic hot & cold water systems should be temperature monitored by the Building Management Systems performing to SHTM 08-05 to ensure compliance with the temperature standards specified in the relevant regulations and guidance. System parameters must be detailed in the Written Scheme for the Water system. The minimum Building Management System performance of the water system must be to ensure:
>
> - Domestic Hot Water is continuously monitored and records the parameters highlighted above i.e. 60°C flow (minimum) from the water heating device to ensure 55°C at the supply to the farthest draw-off (sentinel) point in the circulating system under normal use and no less than 50°C return (lowest limit) to the water heating device;
>
> - Cold Water is continuously monitored and records from the point where it enters a building as described above, i.e. no more than 20°C (highest limit);
>
> - failures outwith the parameters are subject to alarms and service response messages;
>
> - performance data require to be secured and retained for at least 5 years, but must be easily available to the Authorised Person (Water), the other independent professional advisors, assessors and others with an interest in system performance."[206]
>
> "DHW [Domestic Hot Water] and CW [Cold Water] system performance data is valuable for assurance and continuous improvement of Legionellosis risk control. Data should be reviewed and exploited as follows:
>
> - produce a BMS [Building Management System] plot covering a typical week, for each DHW and CW system;
>
> - identify non-compliant systems and prioritise them for remedial actions by risk category;

[206] A32354164 - SHTM 04-01 Part A, July 2014 – Bundle in relation to Water PPP – Page 374. This provision does not feature in v1 of that guidance from August 2011 (archived July 2014).

- repeat the plots on an annual basis and when there is a change e.g. change of use, engineering modifications, etc;

- maintain hard copy records in the Water Safety Log Book."[207]

15.2. The BMS system comprises a network of sensors, meters and controllers, which enable GGC to monitor the performance and condition of the water system. Water meters measure the cold water consumption of particular systems and areas of the hospital.

Temperature recording

15.3. Concern was raised on several occasions regarding the recording of temperature within the hot water system. The lack of records were indicated as making it difficult or impossible to form a true view of the position in that part of the system.

15.4. A Legionella Control AE Audit of 4 May 2017 stated:

> "There are very few measures made of stand alone hot water temperatures. Accordingly, in these records, it is difficult to know how the hot water system is performing in the hospital. It is recommended that temperatures are taken from the hot water pipework that supplies hot water to the Thermostatic Mixing Taps."[208]

15.5. It is not clear what if any remedial action was taken in respect of this concern.

15.6. A 'draft meeting report' of 25 April 2018 produced by Leegionella Ltd stated:

> "Currently there is no information available on water temperatures as there has been a problem with the BMS system and data loss as a consequence. This means the Trust is not able to show due diligence and I am therefore unable to comment on the temperature control regime."[209]

15.7. It is not clear what if any remedial action was taken in respect of this concern.

15.8. Pro Lp Consulting Ltd's Authorising Engineer Management and Compliance Audit dated 28 February and 1 March 2022 stated:

> "The record for the temperatures at the hot outlets appear to be missing for the months of April – only two sheets of records for that month, June, September, October, November and December 2020. Although the temperature records were not available for all months, it was stated that an inspection of the facilities management system, showed that the

[207] A33103411 - SHTM 04-01 Part G, July 2015 – Bundle in relation to Water PPP – Page 493.
[208] A44312599 - Legionella Management and Compliance Audit – Bundle in relation to Water PPP – Pages 1252 and 1253.
[209] A40732034 – Draft meeting report - Bundle 8 for Oral hearing commencing 12 June 2023 – Page 141.

> checks had been undertaken, except for November 2021. The bulk of the hot temperatures that are recorded in the records are from the TMV outlet as it is not allowed to remove IPS panels in many areas without an HAI Scribe. This does not therefore inform us as to what is going on in the hot water flow and return systems with the required level of detail. The BMS does however have end of line sensors within the Adults and Children hospitals and many of these will be on secondary loops. The BMS alarms if the temperatures are getting out of specification at these sensors. It is recommended that non TMV'd hot and cold outlets are identified in areas requiring HAI Scribes for panel removal, in order that a picture can be built up of the hot and cold water temperatures in that particular area, without the need to remove panels. Please note that this recommendation was also made in February 2020. It is recommended that a search is made to attempt to find the missing temperature records for 2020, and if found, that these records are added to the logbook."[210]

15.9. A repeat audit dated 11 January 2023 noted:

> "A review of the records show that the recorded hot temperatures are all hot temperatures from TMT or TMV blended outlets. It is important to know what the actual hot water system temperatures are. It is also conceded that there are situations where it will not be possible to remove lift off panels to get to the hot and cold feeds to the TMVs/TMTs. It is recommended that non TMT'd or TMV'd outlets are used to record the temperatures of the actual hot water temperatures going to the TMT or TMV, or that temperatures are recorded from the surface of hot water pipes going to the TMT's/TMV's."[211] "…it was stated at the time of the audit that these issues are being addressed."[212]

15.10. The report also advised:

> "A review of the records show that the recorded temperatures are all hot temperatures from TMT or TMV blended outlets. It is important to know what the actual cold water system temperatures are. It is also conceded that there are situations where it will not be possible to remove lift off panels to get to the individual cold-water pipes. It is recommended that non TMT'd or TMV'd outlets are used to record the temperatures of the actual cold water temperatures going to the TMT or TMV, or that temperatures are recorded from the surface of cold water pipes going to the TMT's/TMV's."[213]

15.11. It is not clear what if any remedial action was taken in respect of this concern.

15.12. The absence of complete records of temperatures in both the hot and cold

[210] A44312654 - Pro Lp Consulting Ltd Audit 2022 – Bundle in relation to Water PPP – Pages 1414 and 1418.
[211] A44312832 - Pro Lp Consulting Ltd Audit 2023 – Bundle in relation to Water PPP – Page 1438.
[212] A44312832 - Pro Lp Consulting Ltd Audit 2023 – Bundle in relation to Water PPP – Page 1440.
[213] A44312832 - Pro Lp Consulting Ltd Audit 2023 – Bundle in relation to Water PPP – Pages 1438 and 1439.

water systems is a potentially deficient feature for the purposes of Glasgow III.

Control measures other than temperature control

15.13. The reliance upon temperature as a control measure has been identified as a potentially deficient feature. A concern was raised regarding the risk of relying too much on temperature as a means of control, in particular because in a large system it may be difficult or impossible for temperature to be reliably maintained.

15.14. Leegionella Ltd's 'draft meeting report' of 25 April 2018 stated:

> "It is a concern that a hospital intended for high risk patients was not designed with a multiple barrier water safety plan approach and relies solely on temperature as a control measure. It is predictable highly [sic] that in large complex systems that water temperatures are unlikely to meet the control temperature target at every outlet 100% of the time (55°C within one minute at hot outlets and < 20°C within 2 minutes)"[214]

15.15. An Authorising Engineer Water Systems Management and Compliance Audit produced by Pro Lp Consulting Ltd and dated 11 January 2023 advised that, while temperature is the primary means of control within the water systems, it is now supported by the use of chlorine dioxide as a secondary disinfectant.[215]

15.16. The absence of a multiple barrier water safety plan approach and reliance solely on temperature as a control measure is a potentially deficient feature for the purposes of Glasgow III.

Temperature control

15.17. A concern was raised in relation to the design philosophy of the Medium Temperature Hot Water system, which therefore may also have been a potentially deficient feature. The nature and explanation of that concern appears to be highly technical. To avoid potential misunderstanding, the Inquiry team have not attempted to paraphrase or summarise the matter. It has therefore been narrated fully in the paragraph below.

15.18. A Forensic Analysis Report of 10 May 2018 by Innovated Design Solutions stated the following in relation to this concern:

> "From our forensic analysis it would appear there was likely to be inherent irregularities in terms of the original MTHW [Medium Temperature Hot Water] heating primary circulation design philosophy. These may have subsequently resulted in system temperature control instability, and consequently led to the CHP system underachieving

[214] A40732034 – Draft meeting report - Bundle 8 for Oral hearing commencing 12 June 2023 – Page 138.
[215] A44312832 - Pro Lp Consulting Ltd Audit 2023 – Bundle in relation to Water PPP – Page 1441.

intended desired level of performance”[216]

…

“the system was designed with the intention of varying volume flow rate within the primary MTHW distribution circuit as necessary to suit heat load requirements within the Adult and Children’s Hospital, and the Laboratory Building (i.e. to suit demand on the secondary side of heat exchangers). In order to achieve this variable volume strategy, record documentation indicates that the Adult and Children’s Hospital primary MTHW circuit was designed to operate on a constant temperature basis of 105°C flow, and 75°C return, with the Laboratory Building primary MTHW circuit being designed to operate on a constant temperature basis of 105°C flow, and 85°C return. These primary distribution temperatures would afford a mean water temperature at each plate heat exchanger of 90°C and 95°C respectively, and therefore, the associated plate heat exchangers should have been designed and selected to suit these varying mean water temperatures.

“The apparent design decision to operate the primary MTHW circuit serving the Laboratory plate heat exchangers on a differing basis of 105°C flow, and 85°C return, appears to be unusual as this would inevitably result in an increased mixed common primary return temperature above the 75°C indicated on record drawings. This would in all probability have resulted in system temperature control instability, particularly as the CHP operation was noted as being monitored against a set point temperature of 74°C (as detailed in foregoing CHP section).

“From examination of record documents it would appear that the original strategy in terms of operational temperatures has been modified from that initially intended (i.e. fundamentally deviating from the design principle). System modifications have included an alteration to monitor and control the common MTHW primary circuit return temperature to the CHP [Combined Heat and Power] units, apparently endeavouring to restrict this temperature to 74°C (i.e. new dump valve set point, and noted as ‘ideal’ return temperature within User Manual). This alteration appears to have been deemed necessary to maintain performance of the CHP units, however, implementation of this modification does not seem to have taken any cognisance of the associated potential consequential effects.

“System alterations essentially appear to cause variation in primary MTHW flow temperature, lowering it considerably below the original design intent of 105°C. An inevitable effect of this is that it presents the potential for secondary side heat output availability being reduced significantly below intended capacity, in view of the reduction in mean water temperature at heat exchangers.

“The revised strategy appears to be reliant on any secondary side heat

[216] A33795394 - Forensic Analysis Report – Bundle in relation to Water PPP – Page 1268.

load requirement (i.e. LTHW / DHWS) being communicated by a decrease in the primary side MTHW return circuit temperature, which in turn would eventually signal a demand for additional heat load generation (i.e. to enable boilers). Given the probably quantity of system water content, and diverse functions of the various facilities being served via heat exchangers, there would seem to be the potential for a minor increase in heat load demand to be undetected, in view of the insignificant deviation a minor load would likely create in terms of difference in primary side MTHW return temperature being monitored remotely within the Energy Centre.

"If a secondary side heat demand requirement was sufficient to create the necessary temperature differential within the common mixed primary MTHW return circuit, the time taken to effectively convey this via the primary distribution (i.e. be detected/acknowledged/processed by the controls system, acted upon by the boilers, and circuit temperature raised to the necessary level) would in all probability be prolonged. This may extend underperformance/inadequacy experienced by the associated facilities served within the Adult and Children's Hospital.

"In particular, the domestic hot water services appear to have been originally designed on the basis of direct heating utilising MTHW/DHWS plate heat exchangers, as to afford rapid recovery of domestic hot water temperatures, and minimise risks associated with legionella. Given the lower than originally intended operational temperatures observed during our investigation works, and temperatures indicated within the User Manual, the revised control strategy would appear to have resulted in the primary distribution operating on a low temperature hot water basis, and unlikely to afford rapid heat recovery.

"Due to the above, not only do we anticipate there to be a potential risk in relation to relatively low secondary side heat demands being undetected (i.e. from 1 or 2 plate heat exchangers), but the practical duration necessary to rectify the associated thermal inadequacies would appear to be likely prolonged due to the inability of the system, and associated plant, to react (effectively). If the foregoing is found to be transpiring, this would be of particular concern in relation to the domestic hot water services as the subsequent control modification would have potential to increase the risks associated with legionella growth within the system."[217]

15.19. It is not clear what if any remedial action was taken in respect of this concern, and it remains a potentially deficient feature for the purposes of Glasgow III.

Corrosion of water meters

15.20. One of the water meters was identified as a potentially deficient feature of the

[217] A33795394 - Forensic Analysis Report – Bundle in relation to Water PPP – Page 1312 to 1314.

water system due to the identification of corrosion.

15.21. A corrosion report of January 2019 produced by Intertek stated:

> "The water meter (valve) body showed no evidence of external corrosion. Internally corrosion and paint blistering were seen around the section changes close to the flanges and around the neck."[218]

15.22. The cause and significance of this corrosion is not clear from the terms of the report.

15.23. GGC have advised the Inquiry that, in response to this concern, 8 water meters demonstrating minor corrosion were replaced in February 2019 during installation of the Continuous Chlorine Dioxide dosing system.[219]

15.24. These water meters are a potentially deficient feature for the purposes of Glasgow III.

16. Hand wash basins, taps, point-of-use filters

Hand wash basins

16.1. There are hand wash basins throughout the hospital to enable regular hand washing. They give rise to a potential concern due to their being the connection-point between taps and drains, both of which raised issues of concern in their own right. Some were also identified as potentially deficient features due to little use being made of them, the risk being that they might amount to deadlegs.

16.2. SHTM 64 SHTM describes the purpose and features of the hand wash basins as follows:

> "**Basins**
>
> 2.19 Basins should have a smooth form and easily cleaned surfaces. Overflows should not be provided for infection control reasons.
>
> 2.20 Three sizes of basin should fulfil most of the user requirements in health buildings:
>
> [description of purposes of large, small and medium basins]
>
> …

[218] A44312419 – Intertek Examination of Corroded Valve Body – Bundle in relation to Water PPP – Page 1381.
[219] A44311369 - Parts 1(iii), 1(iv) & 2(i) of GGC response to s.21 Notice 8 – Bundle in relation to Water PPP – Page 986.

Basin selection

2.26 When selecting taps for clinical procedures, and certain activities in food-preparation and laboratory areas, taps and supply fittings will be required to be operated without the use of hands.

2.27 Fittings actuated by a proximity sensor are now a preferred alternative to lever-action taps.

2.28 The design team should select the appropriate combinations of basins and taps illustrated on the assembly data sheets for:

- clinical procedures …
- personal washing …
- hand-rinsing …"[220]

16.3. In their 2018 summary of findings related to bloodstream infections in Wards 2A/2B RHC, GGC recorded that an infection concern related to a tap and wash hand basin in 2A had been identified and action taken in 2016:

> "In February 2016 a patient within ward 2A RHC was identified as having a bloodstream infection (BSI) as a result of Cupriavidus pauculus. NHSGGC investigations included water samples from outlets within the aseptic suite of the pharmacy department where the parenteral nutrition was made that the child had received. Cupriavidus pauculus was isolated from water samples taken from a tap on a wash hand basin within this area. Typing by Colindale reference laboratory confirmed the isolate from the washhand basin and the patient were the same. The wash hand basin was subsequently removed as a result"[221]

16.4. Separately, GGC have referred to the removal of a wash hand basin following the February 2016 investigations, not because of a positive test result, but because a concern was raised as to the irregular use of that outlet:

> "Removal of wash hand basin in RHC level Aseptic Pharmacy Suite
>
> Following hypothesis of investigation into Cupriavidus linked incident in Feb 2016 the sink was identified as a little used outlet."[222]

16.5. It is understood that the removal of little used outlets is good practice as a means of avoiding the presence of deadlegs.

16.6. The 2018 summary also records a concern relating to a sink in 2017, although

[220] A33662290 - SHTM 64, Dec 2009 – Bundle in relation to Water PPP – Pages 108 to 110.
[221] A33448003 – HPS Report December 2018 – Bundle for Oral Hearing Commencing 12 June 2023 – Bundle 7 – Page 38.
[222] A44311369 - Parts 1(iii), 1(iv) & 2(i) of GGC response to s.21 Notice 8 – Bundle in relation to Water PPP – Page 980.

in that case the issue appears to have been resolved with chemical treatment:

> "A further single case of Cupriavidus pauculus was identified in September 2017. NHSGGC reported that a second hand hygiene sink was found to be positive but following assessment was unable to be removed. Silver hydrogen peroxide treatment was undertaken and repeat testing resulted in zero total viable counts from this outlet."[223]

16.7. Minutes of a Problem Assessment Group in February 2018 record a regular chemical treatment regime for a sink within the Aseptic Pharmacy. The minutes are ambiguous in relation to whether the concern arose from an incident in September 2017 or September 2016. However, given that the 'background' section of the minutes refers only to a case in September 2017, it appears: (a) that this sink is likely to be the same one as mentioned by GGC and referred to in the paragraph above; and (b) that in September 2017 the link between the cupriavidus infection and the sink was unclear:

> "A 2nd patient case was identified in September 2017 and at that time, no links were made to the previous case or the aseptic pharmacy. More recent investigations found that this patient did in fact have chemotherapy which came from the aseptic pharmacy.
>
> JG also confirmed that the clinical hand wash basin which was a concern resulting from the September 2016 PAG has been re-treated by estates this morning. In addition the sink is cleaned daily with bleach and once weekly with porceine."[224]

16.8. In a Legionella Audit of 4 May 2017, a concern was raised in passing that the cleaning regime in place might disguise the risks posed by basins/sinks being little used:

> "…It may be that the cleaning staff are cleaning every wash hand basin and sink every day, and, as a result, technically these outlets will not be classed as little used. A check should be made to ensure that domestic staff are cleaning all wash hand basins and sinks in the appropriate manner."[225]

16.9. As part of the response to the 2018 Water Incident, in which focus inter alia fell upon the drainage system within wards at RHC, sink drains were specifically referred to as an area of concern in a communication to patients:

> "You may be aware that two of our wards have been experiencing disruption whilst we have introduced an enhanced cleaning programme.

[223] A33448003 – HPS Report December 2018 – Bundle for Oral Hearing Commencing 12 June 2023 – Bundle 7 – Page 38.
[224] A41890259 – PAG Minute 6 February 2018 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 2 - Page 83.
[225] A44312599 - Legionella Management and Compliance Audit – Bundle in relation to Water PPP – Page 1262.

> This is the result of a build-up of material (known as biofilm) in the sink drains in Ward 2A and 2B. This is the same sort of biofilm we get in domestic sink drains but as the patients in these wards are being treated for cancer their immune system is compromised and they are more susceptible to infection"[226]

16.10. Work, including sink replacement, is understood to have taken place until December 2018:

> "work ongoing within Ward 2A/2B. Pipe work modification is ongoing along with the sink/tap replacement. Materials for new treatment room and prep room have been ordered. Everything is currently on target for completion on the original date set for 14th December."[227]

16.11. Following the 2018 Water Incident, an extensive programme of replacement works was undertaken by GGC over the period from October 2018 to March 2022, as is referred to them in a response to the Inquiry. The following entries bearing on sinks/basins are recorded there:

> "replacing the clinical wash hand basins – selected for splash reduction
>
> localized chlorine dioxide system – to commence treatment (earlier than main installation)" [228]

16.12. The extent to which hand wash basins gave rise to the build-up of biofilm, excessive splashing and that some were underused used are potentially deficient features for the purposes of Glasgow III.

Taps, flow straighteners and point-of-use filters

16.13. In relation to the risks of taps, flow straighteners and point-of-use filters, SHTM 04-01 explains:

> "thermostatic mixing [tap] devices have complex internal structures that can entrap waterborne bacteria and biofilm. Risk assessments should be carried out to determine the potential to replace thermostatic mixing devices with ordinary in augmented care accommodation
>
> "…taps should be ideally removable and easily dismantled for cleaning and disinfection
>
> "…Rosettes, flow straighteners and aerators have been found to be heavily colonised with biofilm but their removal can create turbulent flow at increased pressure resulting in splashing of surrounding surfaces and

[226] A38662166 - Briefing dated 18 September 2018 – Bundle for Oral Hearing Commencing 12 June 2023 – Bundle 5 – Page 150.
[227] A36629319 – 22.11.2018 IMT – Bundle for Oral hearing commencing 12 June 2023 – Bundle 1 – Page 238.
[228] A44311369 - Parts 1(iii), 1(iv) & 2(i) of GGC response to s.21 Notice 8 – Bundle in relation to Water PPP – Page 984.

flooring. Current advice is that they should be removed but this should be subject to risk assessment."[229]

"Point-of-use filters have been found to provide protection from exposure to bacteria such as Legionella and Pseudomonas by preventing the dispersal of bacteria from showers and other water outlets.

"…The filters do not eradicate the organism but prevent discharge to the environment from the filtered outlet only; by retaining the organism within the pipework, it may be possible for the organisms to multiply and regressively 'seed' other parts of the distribution system."

"Filters will also need to be changed routinely, depending on usage of the outlets. Their use should be considered only as part of an overall regime of bacterial control to be used where the most vulnerable patients are treated. Installation of point-of-use filters should be risk assessed and designers should be aware of the reduced flow that will arise from increased resistance."[230]

Flow straighteners

16.14. Flow straighteners were identified as a potentially deficient feature of the water system. An SBAR of April 2014 advised that GGC sought advice from Health Protection Scotland (HPS) on the use of 'Horne Optitherm' taps. These taps incorporated 'flow straighteners' and had been procured for all clinical environments within the new QEUH and RHC. UK and Scotland-wide pseudomonas guidance published in June 2013 had subsequently advised that flow straighteners could develop biofilm and recommended for flow straighteners to be removed from taps.[231]

16.15. HPS recommended that GGC install the procured taps in all clinical areas other than those in high risk units, where the flow straighteners could either be removed or new compliant taps without flow straighteners could be fitted instead.[232]

16.16. A special meeting to discuss Optitherm taps was convened on 5 June 2014 and attended by GGC and HFS. The minutes stated the meeting had been

[229] A32354164 - SHTM 04-01 Part A, July 2014 – Bundle in relation to Water PPP – Pages 320 and 317. These provisions do not feature in v1 of that guidance from August 2011 (archived July 2014).
[230] A32354164 - SHTM 04-01 Part A, July 2014 – Bundle in relation to Water PPP – Page 280. A similar provision features in v1 of that guidance from August 2011 (archived July 2014).
[231] A37746908 – SBAR dated April 2014 – Bundle for Oral Hearing Commencing 12 June 2023 – Bundle 3 - Page 5.
[232] A37746908 – SBAR dated April 2014 – Bundle for Oral Hearing Commencing 12 June 2023 – Bundle 3 - Page 6.

requested by GGC to review their situation.[233] The minutes noted:

> "it was unanimously agreed that as the taps installed within the new build development had complied with guidance current at the time of its specification and briefing and that the hospital was in the process of being commissioned, it should be regarded as being in the 'retrospective' category, not "new build". There was no need to apply additional flow control facilities or remove flow straighteners and any residual perceived or potential risks would form part of the routine management process."[234]

16.17. HFS' Water Management Issues Technical Review of March 2019 advised in relation to this matter:

> "There is evidence from the contractor that percentages of the Horne taps failed the initial disinfection tests, were disinfected and retested (a month-and-a-half) later and failed the second test. There is no evidence within ZUTEC of any additional testing to resolve these failures. There is also evidence that as a result of re-disinfection, some retested outlets passed the second test (after first failure)."[235]

16.18. The extent to which the use of flow straighteners in taps gives rise to a potentially deficient feature for the purposes of Glasgow III is discussed at paragraphs 16.25 to 16.36 below.

Servicing and testing of Thermostatic Mixing Valve taps

16.19. The DMA 2015 report advised that the vast majority of hot outlets were fed via Thermostatic Mixing Valves taps ("TMV") – 'Horne' taps in clinical areas and 'Markwik' taps in non-clinical areas.[236] DMA recommended that TMVs should be serviced and have fail safe tests carried out routinely. DMA further recommended that strainers should be cleaned on a regular basis.[237]

16.20. In their report of 2018, DMA raised concerns with respect to those recommendations. DMA advised:

> "TMV servicing in high risk areas…has recently been carried out by DMA as we were advised the Estates regime may have lapsed. Servicing of some outlets (e.g. Armitage Contour Taps) is restricted as

[233] A39465202 - Special meeting to discuss Opitherm taps – Bundle in relation to Water PPP – Page 816.
[234] A39465202 - Special meeting to discuss Opitherm taps – Bundle in relation to Water PPP – Page 818.
[235] A33448015 – HFS Water Management Issues Technical Review – Bundle for Oral Hearing Commencing 12 June 2023 – Bundle 7 - Page 100.
[236] A33870103 – DMA L8 Risk Assessment, 1 May 2015 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 138.
[237] A33870103 – DMA L8 Risk Assessment, 1 May 2015 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 232.

DMA have been advised we are unable to remove IPS panels. This gives further cause for concern as Estates were unable to confirm if the strainers on the supplies have ever been removed for cleaning/disinfection or taps fully serviced.

"…Horne Optitherm TMV taps are designed to be demounted for maintenance and servicing elsewhere but the facilities for this are yet to be completed and commissioned.

"...In addition, the strainers located on the supplies to the TMV taps in 'Non-Clinical' areas (e.g. patient, visitor and staff toilets) are located behind panels and therefore infection control procedures are required (Scribe) in order to remove panels for service. We understand no servicing of any of these valves and the associated strainers in non-high risk areas has been carried out since the hospital opened and there has been a very limited program of servicing in 'high risk' areas.

"We are unaware of any servicing works being carried out and had access to servicing records on TMV taps in other areas of the hospital at the time of assessment"

"The recent (prior to assessment delivery) issue with regards to Cupriavidus bacteria being detected in the system water has highlighted that the servicing requirements of the TMV taps should be reviewed to ensure that in addition to manufacturers service instructions being carried out the servicing of TMV taps includes any additional control measures as deemed necessary by infection control e.g. full thermal bypass/disinfection of the taps where practicable and safe (this would require to be carried out remotely from patient areas) and flow regulator, O rings and other components cleaning, disinfection and/or replacement." [238]

16.21. DMA concluded that the six monthly servicing of TMV's, including fail safe tests and cleaning/disinfection of strainers, was not being carried out at that time.

16.22. An GGC review of this recommendation dated 29 January 2019 stated:

"All High Risk areas have had TMT servicing and maintenance carried out until most recently when Point of Use (PoU) filters were installed. The only area where routine maintenance is not being carried out is on taps and showers across the QEUH/RHC. This will begin once the full water system chlorinisation project at the QEUH has been completed. High Risk Areas are currently protected by PALL filters installed at each outlet. All reactive maintenance is being auctioned through FMFirst (CaFM System)."[239]

[238] A33870243 – DMA Canyon L8 Risk Assessment, Final Submission 25 April 2018 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 602.
[239] A33869445 – GGC Review of DMA Recommendations, 29 January 2019 – Bundle 8 for Oral hearing commencing 12 June 2023 – Page 96.

16.23. An Authorising Engineer Management and Compliance Audit produced by Pro Lp Consulting Ltd and dated 11 January 2023 advised that TMVs are serviced by DMA once a year. The auditors recommended for the practicability of twice yearly servicing to be reviewed and that a confirmed, risk assessed and agreed way forward was created.[240]

16.24. The extent to which the testing and servicing of TMV taps gives rise to a potentially deficient feature for the purposes of Glasgow III is discussed at paragraphs 16.25 to 16.36 below.

Organisms in taps

16.25. At an IMT meeting of 2 March 2018, it was noted that one outlet in room 3 of Ward 2A had tested positive for Pseudomonas aeruginosa.[241] Taps and showerheads were removed for components to be swabbed and tested. The IMT stated:

> "Hypothesis is that outlets are the source and that seeding of others has taken place. Flow straighteners which encourage biofilm formation are known to be high risk and have been implicated in outbreaks previously."

16.26. Due to the number of outlets positive in a high-risk area, it was decided to proceed to Silver Hydrogen peroxide dosing straight away.[242] It was decided that outlets would be replaced starting with those that had tested positive, but the recommendation was for all to be changed. It was also decided that resampling would take place once dosing was complete.

16.27. At an IMT of 6 March 2018 it was noted that initial sampling carried out on a removed tap showed Cupriavidus growing from the hot tap and flow straightener.[243] It was decided that all taps would be removed from patient rooms, with flow straighteners changed and sanitised.[244] The timeline produced by the GGC Oversight Board notes that flow straighteners would be replaced on a 3 monthly basis.[245] It was also noted in the IMT of 6 March 2018 that routine testing of the water outlets would take place monthly.

16.28. At an IMT of 9 March 2018 it was noted that visual inspection of the

[240] A44312832 - Pro Lp Consulting Ltd Audit 2023 – Bundle in relation to Water PPP – Page 1441.
[241] A36690451 – 02.03.2018 IMT – Bundle for Oral hearing commencing 12 June 2023 – Bundle 1 – Page 54.
[242] A36690451 – 02.03.2018 IMT – Bundle for Oral hearing commencing 12 June 2023 – Bundle 1 – Page 55.
[243] A36690471 – 06.03.2018 IMT – Bundle for Oral hearing commencing 12 June 2023 – Bundle 1 – Page 57.
[244] A36690471 – 06.03.2018 IMT – Bundle for Oral hearing commencing 12 June 2023 – Bundle 1 – Page 58.
[245] A33448013 – Oversight Board Infection Timeline - Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 958.

thermostatic mixing valve component showed green pigmentation in keeping with bacterial growth. Laboratory results were awaited.[246] It was also stated that all TMV thermostat mixing taps had multiple components in them with complex structures making it easy for microorganisms to grow.

16.29. At an IMT of 12 March 2018, it was noted that microbiology results from the testing of the taps had returned multiple positive results for Cupriavidus and two results for Stenotrophomonas, described as a significant pathogen within the patient group in Ward 2A.[247] Due to the number of positive results which came back emergency measures were put in place including the provision of sterile water for drinking and bottled water for washing and bathing.[248]

16.30. At an IMT of 16 March 2018 it was noted there had been three additional hospital acquired bacteraemia cases. It was agreed that filters would be put onto every tap within the wards affected, with Ward 2A being prioritised if filters were limited.[249] At an IMT meeting of 19 March 2018 it was agreed that control measures could be lifted once the filters were fitted to the taps and negative results had been obtained.[250]

16.31. At an IMT of 21 March 2018 it was noted that, despite the system being dosed four times and counts being lowered, Cupriavidus was still present in a number of outlets. Ward 2B and 3C were described as having widespread Cupriavidus, while multiple water samples were positive from outlets in Ward 4B.[251]

16.32. It was agreed that Facilities would carry out tests on the water outlets on a weekly basis to ensure filters were working once installed. If counts started to get high then filters on affected outlets could be changed. It was noted that the filters being fitted to the taps had a working life of 30 days. Facilities were introducing a rolling program to change these filters from day 25.[252]

16.33. At an IMT of 23 March 2018 it was noted that numerous environmental gram negative pathogens were returned from swabs taken of taps from Ward 2A,

[246] A36690458 – 09.03.2018 IMT – Bundle for Oral hearing commencing 12 June 2023 – Bundle 1 – Page 60.
[247] A36690457 – 12.03.2018 IMT – Bundle for Oral hearing commencing 12 June 2023 – Bundle 1 – Page 63.
[248] A36690457 – 12.03.2018 IMT – Bundle for Oral hearing commencing 12 June 2023 – Bundle 1 – Page 64.
[249] A36690477 – 16.03.2018 IMT – Bundle for Oral hearing commencing 12 June 2023 – Bundle 1 – Page 69.
[250] A36690507 – 19.03.2018 IMT – Bundle for Oral hearing commencing 12 June 2023 – Bundle 1 – Page 71.
[251] A36690549 - 21.03.2018 IMT – Bundle for Oral hearing commencing 12 June 2023 – Bundle 1 – Page 76.
[252] A36690549 - 21.03.2018 IMT – Bundle for Oral hearing commencing 12 June 2023 – Bundle 1 – Page 78.

RHC and Ward 4B QEUH.[253] By an IMT of 27 March 2018 it was noted:

> "The group agreed to step down the Infection Control measures put in place for affected wards within the QEUH and RHC sites as point of care filters have been fitted to all water outlets and showers. Patients can now use the CHWB to carry out hand hygiene and also use the showers if required. Patients no longer require Ciprofloxacin.
>
> "The only issue is with drinking water which IPCT will include in their communication email.
>
> "Post IMT it was agreed to proceed with [lifting precautions on] BMT patients but that filters would need to be changed every 7 days as we have proven microbiological efficacy to that point. This will mean BMT patients can shower."[254]
>
> "Dr Inkster informed the group that this IMT will be disbanded from today as it has dealt with all the acute issues. A separate group consisting of IPCT, Facilities, HPS and HFS will look into the remit of filter replacement, introduction of new taps, introduction of chlorine dioxide dosing to the water system and drain cleaning."[255]

16.34. GGC have advised the Inquiry that from October 2018 to March 2022, material changes were made to the water system including in RHC Ward 2A and 2B replacing taps with a different model for easier maintenance.[256]

16.35. At an AICC (Acute Infection Control Committee) meeting of 18 September 2020, a number of out of specification results (including Stenotrophomonas) were returned from various filtered taps in RHC Ward 1C PICU/QEUH Ward 6A and other wards.[257] It was agreed that the cleaning regime and refresher training would be reviewed with Facilities. The filters in the affected taps were sent for testing, with the Water Technical Group later highlighting in their meeting of 18 September 2020 the potential risk for contamination behind the filters.[258] The Inquiry team therefore understand that the nature of this concern is an ongoing one, dependent on appropriate operational procedures in order to be managed.

16.36. As a consequence, the fitting of TMV taps with flow straighteners, the

[253] A36690544 – 23.03.2018 IMT – Bundle for Oral hearing commencing 12 June 2023 – Bundle 1 – Page 82.
[254] A36690556 – 27.03.2018 IMT – Bundle for Oral hearing commencing 12 June 2023 – Bundle 1 – Page 88.
[255] A36690556 – 27.03.2018 IMT – Bundle for Oral hearing commencing 12 June 2023 – Bundle 1 – Page 90.
[256] A44311369 - Parts 1(iii), 1(iv) & 2(i) of GGC response to s.21 Notice 8 – Bundle in relation to Water PPP – Page 984.
[257] A32700430 - AICC paper 30 September 2020 – Bundle in relation to Water PPP – Page 913.
[258] A38668806 - Water Technical Group Meeting 18 September 2020 – Bundle of documents in respect of the Water Technical Group / Water Review Group Minutes in relation to the Glasgow 3 Hearings - Page 200.

servicing and testing regime for those taps, and the time taken to replace those taps are all potentially deficient features for the purposes of Glasgow III.

17. Stainless steel sinks and taps, trough sinks

17.1. This section refers to trough sinks which are different from hand wash basins and exist for medical staff to clean their hands and forearms. These were identified periodically as a risk due to their being used infrequently, creating a risk that their presence might constitute a deadleg; and from splashing, distributing water over a wider area.

17.2. SHTM 64 describes the purpose and features of these as follows:

> "**Scrub-up troughs**
>
> 2.37 Scrub-up troughs should be provided to enable one or more surgeons and nurses to scrub their hands and forearms.
>
> 2.38 Troughs should be wall-hung and fitted with a single waste outlet.
>
> 2.39 Taps should be wall-mounted and deliver safe, thermostatically (TMV3 D08) controlled hot water …
>
> 2.40 For infection control reasons sensor-controlled fittings are generally required for controlling the flow of water at scrub-up troughs and these can also offer the additional benefit of controlled run times. The relationship between the taps and the trough is critical in order to avoid splashing." [259]

17.3. An SBAR was raised on 17 October 2016 as part of an investigation into an outbreak of Serratia:

> "**Situation**
>
> Following an increased incidence of Serratia marcescens, the IPCT and clinical staff reviewed the use of sinks in the unit. The trough sinks in the trolley bays are very close to a number of procedure trolleys. This adds a risk of water splashing from tap water and also soap scum onto the procedure trolleys during scrub.
>
> **Background**
>
> Ward 1D, PICU, has two trolley bays that each have a trough sink. The rational was that these sinks would be used to undertake surgical scrub if a surgical procedure was required in one of the single rooms, since none of the single rooms have trough sinks. The trough sinks in the trolley bays are not used very often and therefore pose a risk. Removal of little-used outlets is recommended by HPS as good practice to

[259] A33662290 - SHTM 64, Dec 2009 – Bundle in relation to Water PPP – Pages 110 and 111.

reduce the risk to patients from water borne organisms" [260]

17.4. It was recommended that, if feasible, trough sinks should be removed from the trolley bays in question, and as a replacement measure, trough sinks should replace hand wash basins in the nearby single rooms.[261]

17.5. GGC have informed the Inquiry that subsequent to the SBAR, on or around 10 March 2017, the water on the unit tested negative. They have also informed the Inquiry that the replacement work was carried out in February 2018:

> "Trough sinks removed from trolley bays in Ward 1D PICU. In response to PAG Investigation into 3 serratia cases."[262]

17.6. In June 2018, an Incident Management meeting investigating Acinetobacter in RHC made reference to a decision to remove further trough sinks from common areas into individual rooms:

> "A total of 3 trough sinks identified in a previous IPCT meeting were to be removed from the corridor and placed into rooms."[263]

17.7. Minutes in July 2018 recorded this work as not proceeding for the time being:

> "The removal of the trough sinks will be put on hold until an alternative trough sink can be procured and fitted into the ante rooms. The current clinical hand wash basin within patient rooms are too small for a surgical scrub technique."[264]

17.8. DMA Canyon's Water System Risk Assessment of January 2019 recorded the replacement of trough sinks as being among the measures undertaken in late 2018 to address the issues which had arisen within RHC:

> "In late 2018 Wards 2A & 2B in the Children's Hospital was closed to allow for extensive alterations to be made to the local water system, running hot flow and return services as close as is practical to the outlets, changing taps and WHBs, trough sinks removed from anterooms within the isolation rooms in 2A and other rooms repurposed to suit ward operations."[265]

[260] A38694859 – SBAR 17 October 2016 trough sinks in trolley bays – Bundle for Oral hearing commencing 12 June 2023 – Bundle 4 – Page 53.
[261] A38694859 – SBAR 17 October 2016 trough sinks in trolley bays – Bundle for Oral hearing commencing 12 June 2023 – Bundle 4 – Page 53.
[262] A44311369 - Parts 1(iii), 1(iv) & 2(i) of GGC response to s.21 Notice 8 – Bundle in relation to Water PPP – Page 981; NB also A38172003 - IMT 4 December 2017 – Bundle in relation to Water PPP – Page 821, in which it was noted that the replacement of the trough sinks had not yet occurred.
[263] A37989601 – 06.06.2018 IMT – Bundle for Oral hearing commencing 12 June 2023 – Bundle 1 – Page 106; Minutes of 3 July 2018 [A37990970 – 03.07.2018 IMT – Bundle for Oral hearing commencing 12 June 2023 – Bundle 1 – Page 144] recorded that this was to be followed-up.
[264] A37991121 – 06.07.2018 IMT – Bundle for Oral hearing commencing 12 June 2023 – Bundle 1 – Page 146.
[265] A33870454 - DMA Canyon Water System Risk Assessment, January 2019 – Bundle in relation to Water PPP – Page 1369.

17.9. The use of trough sinks in locations where they posed a risk of splashing or were likely to be underused is a potentially deficient feature for the purposes of Glasgow III.

18. Showers, flexible hoses, particularities of single-occupancy rooms

Flexible hoses

18.1. The use of flexible hoses is identified as a potentially deficient feature of the hospital water system. Unlike fixed piping, their flexibility requires the use of a material the presence of which may of itself create a risk factor. The flexible lining of such hoses may be made of a material which could form a location for contamination.

18.2. In relation to flexible hoses, SHTM 04-01 advises:

> "Flexible hoses (also known as "tails") have become a convenient method of connecting between hard pipework and sanitary fittings or equipment. They typically comprise a steel braided outer sheath with a synthetic rubber inner lining. Reports have been received intimating that high levels of Pseudomonas and Legionella bacteria have been found in water samples taken from outlets fed by flexible hoses lined with ethylene propylene diene monomer (EPDM) due to colonisation of the lining, although it is possible that other lining materials and washers within couplings could be similarly affected.
>
> "…In view of this, it is recommended that the use of flexible hoses in potable water supplies should be identified and risk assessed, taking account of areas of highest risk involving persons vulnerable to infection…In new-build projects flexible hoses should not be specified in such situations
>
> "…All flexible hoses must be WRAS approved."[266]

18.3. In relation to the particularities of single-use rooms discussed later in this section, SHTM 04-01 advises:

> "Where taps or water outlets are not, or are unlikely to be, in regular daily use, Management Team Duty Holders and their staff should be alerted and reminded to flush these through and purge to drain, or purge to drain immediately before use, without release of aerosols."[267]
> "Local flushing regimes must be ongoing and continuous at all times, in

[266] A32354164 - SHTM 04-01 Part A, July 2014 – Bundle in relation to Water PPP – Pages 327 and 328. The same provision is in v1 of that guidance from August 2011 (archived July 2014).
[267] A33103411 - SHTM 04-01 Part G, July 2015 – Bundle in relation to Water PPP – Page 550.

order to prevent critical increases in Legionella growth"[268]

18.4. At the QEUH, almost all patients are accommodated in ensuite single side rooms. This provided at least four water outlets for every patient when the hospital opened.

18.5. DMA's 2015 report advised:

> "Flexible hoses have been noted in Kitchen/Pantry areas where there are flexible connections to dishwashers (not all fitted at present), in Facilities rooms (connections to double level sinks), in Dirty Utility rooms (connections to sluice machines) with the only patient areas DMA have noted as having flexible hoses being the connection to Arjo baths (both connections to the hot/cold system and internally within the actual bath). Wherever possible DMA would recommend all flexi hoses are removed and connections hard piped. Where flexible hoses cannot be removed then replacing with alternative WRAS approved hoses with linings other than EPDM should be considered…Flexible hoses have also been noted on the boosted bulk water system on pressure reducing valves. If possible these should be hard piped (stainless steel) or WRAS approved hoses with linings other than EPDM should be considered. Should these not be available for these types of units/connections then a regular inspection and replacement schedule should be implemented for these. DMA were advised by Mercury Engineering and Estates that all materials fitted during the construction are WRAs approved and therefore do not support bacterial growth… The use of EPDM flexible hoses in some areas may contradict this statement and their use should be reviewed to ensure compliance."[269]

18.6. GGC have advised the Inquiry that the exchange of flexible hoses commenced in January 2017, in response to DMA's 2015 report.[270]

18.7. However the DMA reports of 25 April 2018 and January 2019 noted similar concerns regarding flexible hoses:

> "EPDM flexible hoses have been installed in a small number of non-clinical areas with the only patient areas DMA have noted as having flexible hoses being the connection to Arjo baths…Flexible hoses have also been noted on the boosted bulk water system on pressure reducing valves."[271]

18.8. GGC reviewed the recommendations from DMA's 2018 assessment on 29

[268] A33103411 - SHTM 04-01 Part G, July 2015 – Bundle in relation to Water PPP – Page 573.
[269] A33870103 – DMA L8 Risk Assessment, 1 May 2015 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 232.
[270] A44311369 - Parts 1(iii), 1(iv) & 2(i) of GGC response to s.21 Notice 8 – Bundle in relation to Water PPP – Page 980.
[271] A33870243 – DMA Canyon L8 Risk Assessment, Final Submission 25 April 2018 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 426; A33870454 - DMA Canyon Water System Risk Assessment, January 2019 – Bundle in relation to Water PPP – Page 1374.

January 2019. It was noted in response to this concern:

> "Arjo bath flexible hoses were changed out for WRAS hoses and are replaced on a rolling 2 year program. Regarding flexible hoses on the boosted bulk water system, it was confirmed by AP Water (Jim Guthrie) that the whole valve as an assembly with the hoses is WRAS approved."[272]

18.9. It is not known if this resolved the concern.

18.10. The use of flexible hoses in potable water supplies until removed is a potentially deficient feature for the purposes of Glasgow III,

Organism growth in shower heads

18.11. The shower heads are also identified as potentially deficient features. In much the same way as 'deadlegs', shower heads may see infrequent use such that water may persist for a time within them, carrying the risk of stagnancy and organic growth.

18.12. The Scottish Ministers have advised the Inquiry that, in January 2018:

> "testing yielded positive results for various gram negative organisms and fungal growth in…shower heads (including wards 2A, 2B and 4B)"[273]

18.13. Showerhead components were removed and sent to a microbiology lab for testing on 2 March, revealing the presence of Cupriavidus.[274]

18.14. GGC have advised the Inquiry that from 1-12 March 2018 all shower heads in RHC Ward 2A were replaced.[275] However GGC have also advised that, on 12 March 2018, shower heads tested positive for Cupriavidus and Stenotrophomonas. Further positive results were noted on 21 March despite chemical dosing.[276]

18.15. GGC have advised that disposable shower heads were fitted initially before POU [Point Of Use] heads were fitted in late March.[277]

18.16. A report produced for an GGC Acute Infection Control Committee meeting of

[272] A33869445 – GGC Review of DMA Recommendations, 29 January 2019 – Bundle 8 for Oral hearing commencing 12 June 2023 – Page 98.
[273] A44411439 - Scottish Ministers Response to s.21 Notice number 8 – Bundle in relation to Water PPP – Page 690.
[274] A44411439 - Scottish Ministers Response to s.21 Notice number 8 – Bundle in relation to Water PPP – Page 692.
[275] A44311369 - Parts 1(iii), 1(iv) & 2(i) of GGC response to s.21 Notice 8 – Bundle in relation to Water PPP – Page 981.
[276] A44311391 - Part 1(i) of GGC response to s.21 Notice number 8 – Bundle in relation to Water PPP – Pages 948 and 949.
[277] A44311369 - Parts 1(iii), 1(iv) & 2(i) of GGC response to s.21 Notice 8 – Bundle in relation to Water PPP – Page 981.

30 September 2020 stated:

> "Both showers with ICE [Imaging Centre of Excellence] Building returned out of spec's for legionella including LP1 in one shower. Full maintenance of these taps and TMV's have been carried out. However out of spec results retuned [sic]. Further investigates [sic] are being carried out by the team on site including Estates/DMA (Water Service Provider)."[278]

18.17. It appears from this report that the relevant shower heads were replaced for 'Dupal fixed head showers' and that these would be exchanged every 3 months. It is not clear if this resolved the concern.

18.18. The same report advised:

> "**QEUH Ward 6A (FILTRED [sic] TAPS)**
>
> A number of out of specs from various FILTRED [sic] TAPS AND SHOWERS including:-
>
> High TVC's
>
> Sphingomonas Paucimobilis
>
> Micro bacterium Flavsecens
>
> Acidetbacter Iwoffii
>
> Stenotrophomonas Maltophilia
>
> M Sterilla
>
> H.Hyhomcete
>
> Discussions have taken place with Infection Control, Microbiology regarding these. Additionally liaised with Facilities to review cleaning regime as per agreed procedures. Facilities Management are carrying out refresher training.
>
> In all cases the filters are changed and Estates have arranged for 11 of the filters to be sent to PAL for integrity testing which was agreed with Infection Control and Microbiology. Further analysis and possible caused [sic] should be discussed at the Water Technical Group."[279]

18.19. It is not clear what if any further remedial actions were taken in respect of this concern. The uses of shower heads in en suite facilities that see infrequent use is a potentially deficient feature for the purposes of Glasgow III.

[278] A32700430 - AICC paper 30 September 2020 – Bundle in relation to Water PPP – Page 911.
[279] A32700430 - AICC paper 30 September 2020 – Bundle in relation to Water PPP – Page 913.

Cleaning and disinfection of shower units

18.20. Separately, a concern arose regarding the cleaning of shower heads and the related issue of the need to replace them. A lack of records meant that it was difficult or impossible to be sure that these had been adequately maintained.

18.21. DMA's report of 25 April 2018 stated:

> "NHS Estates are unable to confirm the service history of the [shower] units and cleaning and disinfection of shower heads we would advise consideration is given to changing all heads and hoses with new WRAS approved heads and hoses."[280]

18.22. SHTM 04-01 recommends that shower heads are disinfected quarterly or as necessary.[281]

18.23. GGC have advised the Inquiry that non filtered shower heads and hoses were replaced with recyclable alternatives in May 2019.[282] It is not clear if this was in response to DMA's 2018 report. Pro Lp Consulting Ltd's Authorising Engineer Management and Compliance Audit dated 28 February and 1 March 2022 advised:

> "Showers are replaced on a quarterly basis. This is the case on any parts of the building where POU shower filters are not used. Where POU filters are used they are replaced as required and the shower hose is replaced at the same time or at least quarterly."[283]

18.24. A repeat audit of 11 January 2023 advised that shower heads and hoses are renewed every three months by DMA Canyon Ltd and the records can be found in the Teams system.[284]

18.25. It appears to be the case that GGC are now replacing shower heads frequently. However for some time after occupation of the hospital it is not clear that showerheads were being properly cleaned and disinfected. These are potentially deficient features for the purposes of Glasgow III.

Overprovision of outlets

18.26. A particularity of QEUH is in its provision of single-occupancy rooms throughout the hospitals. This arrangement means that, each room having individual taps, showers, toilets, etc., there are considerably more outlets than

[280] A33870243 – DMA Canyon L8 Risk Assessment, Final Submission 25 April 2018 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 426.
[281] A32354164 - SHTM 04-01 Part A, July 2014 – Bundle in relation to Water PPP – Page 292. The same provision is in v1 of that guidance from August 2011 (archived July 2014).
[282] A44311369 - Parts 1(iii), 1(iv) & 2(i) of GGC response to s.21 Notice 8 – Bundle in relation to Water PPP – Page 986.
[283] A44312654 - Pro Lp Consulting Ltd Audit 2022 – Bundle in relation to Water PPP – Page 1414.
[284] A44312832 - Pro Lp Consulting Ltd Audit 2023 – Bundle in relation to Water PPP – Page 1438.

would be present in a hospital following multiple-occupancy ward design. The potential deficiency arising from this is that consequently there were more points of risk.

18.27. The draft meeting report of 25 April 2018 produced by Leegionella Ltd noted:

> *"It was felt that there was overprovision of outlets which contributes to low flow* in parts of the system; particularly patient ensuite bathrooms. There are several reasons why designers overprovide on the number of washhand basins:- Sadly the formula for working out the number of outlets has not changed for decades and does not take into account the reduced need for WHBs [Wash Hand Basins] in modern healthcare because: less handwashing is carried out as a result of the increased use of alcohol gels. Patient stays are much shorter and when in hospital; patients are generally much sicker so they do not use outlets as frequently as previously (if at all). The move to single en suite facilities with showers compounds the problem; consideration should be given to providing en suites with a toilet and a wash hand basin but communal showers to reduce the risk of stagnation"[285]

18.28. Leegionella Ltd recommended:

> "review the numbers and placement of washhand basins and remove those deemed unnecessary. The installation of flow sensors may indicate where there is a lack of use and the potential for stagnation. The WSG [Water Safety Group] in consultation with the users should agree where washhand basins should be retained and if a flushing regime needs to be implemented. Self-flushing outlets installation, based on local risk assessment, may reduce the risk of the human factor especially where there are access problems such as in isolation rooms"[286]

18.29. It is not known what if any remedial action was taken to address this concern.

18.30. It is recognized that this potentially deficient feature arises at a particularly fundamental level of the concept of a hospital with 100% en suite single rooms, but it is a potentially deficient feature for the purposes of Glasgow III

Mould in shower areas

18.31. Concerns arose around the visual identification of mould within shower areas. Mould indicates the presence of organic material.

18.32. The Scottish Ministers have advised the Inquiry that, on 17 January 2019, two

[285] A40732034 – Draft meeting report - Bundle 8 for Oral hearing commencing 12 June 2023 – Pages 138 and 139.
[286] A40732034 – Draft meeting report - Bundle 8 for Oral hearing commencing 12 June 2023 – Page 139.

rooms in Ward 6A were taken out of use due to evidence of mould in the shower areas.[287]

18.33. An IMT Minute of 25 January 2019 stated:

> "the contractor in charge of the shower work…informed…that 80% of the showers were affected by mould. The contractor said that if there is a break in the shower sealant then the gyprock behind the sealant was not water resistant, but informed them this has been rectified. As an extra precaution the water seals have been raised further up the wall from the flooring. The whole ward will be finished by Monday 28th January where a member of the IPCT will carry out a walk round with estates before an HPV clean is carried out."[288]

18.34. In relation to this concern a timeline of incidents produced by the GGC Oversight Board noted:

> "there was a large volume of black mould in all the bathrooms which posed risk of fungal infections to patients and which was caused by water hitting a defective join and water damage to the surrounding areas (these were supposed to be waterproof but were not)."[289]

18.35. A Case Note Review Overview Report commissioned in 2020 by the Cabinet Secretary for Health and Sport advised that patients transferred out of the ward due to these concerns were returned on 11 February 2019.[290] The Inquiry team therefore understand the concern to have been resolved.

18.36. Whilst this particular concern was resolved the fact that black mould grew in around fourth fifths of showers is a potentially deficient feature for the purposes of Glasgow III.

Insufficient backflow protection

18.37. Insufficient backflow protection on shower heads was also noted as a potentially deficient feature, representing a risk that contaminated water might flow in a direction unintended by the purpose of the shower unit.

18.38. Scottish Water Byelaws Inspection Reports of 28 February 2020 and 10 March 2023 identified numerous instances of insufficient backflow protection in shower heads across the QEUH site.[291] It is not known what remedial

[287] A44411439 - Scottish Ministers Response to s.21 Notice number 8 – Bundle in relation to Water PPP – Page 700.
[288] A36690577 – 25.01.2019 IMT – Bundle for Oral hearing commencing 12 June 2023 – Bundle 1 – Page 292.
[289] A33448013 – Oversight Board Infection Timeline - Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 949.
[290] A33448007 – Case Note Review Overview Report –Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 995.
[291] A43262538 - Scottish Water Byelaws Inspection Report, 28 February 2020 – Bundle in relation to

actions if any have been taken to address those concerns. The lack of backflow protection in shower heads is a potentially deficient feature for the purposes of Glasgow III.

19. ARJO Baths

Hoses serving Arjo baths

19.1. Arjo baths are specialist bathing apparatus which take a number of forms, being medically-adapted to facilitate bathing for those with particular mobility needs. They are present throughout QEUH. They were identified as a potentially deficient feature due to the method of their connection to the water system, which was generally by means of flexible hoses (for which see above). They were also identified as a potentially deficient feature due their lack of sufficient backflow protection, which reduces the risk that contaminated water might flow in a direction unintended by the purpose of the bath.

19.2. On 25 April 2018 QEUH received an L8 Risk Assessment from DMA Canyon, which noted a concern in relation to Arjo baths in 'Various locations throughout the hospital (Wards)'. DMA were unable to confirm the extent of the use of these facilities. DMA observed that connections to the Arjo baths from the hot/cold water systems were by means of flexible hoses, the presence of which might pose a high legionella risk, if used infrequently. DMA recommended that the baths be maintained:

> "in accordance with manufacturers/installers instructions. Where flexible hoses (i.e. internal to bath unit) cannot be removed then replacing with alternative WRAS approved hoses with linings other than EPDM should be considered."[292]

19.3. DMA also recommended that some shower hoses were sufficiently long as to be able to reach into adjacent areas, and recommended:

> "Consider shortening shower hoses as it was noted that these can in some areas reach into adjacent WCs and WHBs"[293]

19.4. The recommendation in respect of flexible hoses and their linings was repeated by DMA Canyon in January 2019 in their 'Water System Risk Assessment':

> "EPDM flexible hoses have been installed in a small number of non-

Water PPP – Page 1390; A43262488 - Scottish Water Byelaws Inspection Report, 10 March 2023 – Bundle in relation to Water PPP – Page 1446.
[292] A33870243 – DMA Canyon L8 Risk Assessment, Final Submission 25 April 2018 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 583.
[293] A33870243 – DMA Canyon L8 Risk Assessment, Final Submission 25 April 2018 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 583.

> clinical areas with the only patient areas DMA have noted as having flexible hoses being the connection to Arjo baths (both connections to the hot/cold system and internally within the actual bath). Wherever practicable DMA would recommend all flexi hoses are removed and connections hard piped. Where flexible hoses cannot be removed then replacing with alternative WRAS approved hoses with linings other than EPDM should be considered. In healthcare premises additional guidance on the replacement and use of flexible hoses is provided in the "safety action notice SAN(SC)09/03". [294]

19.5. A Review of DMA's recommendations dated 29 January 2019 reported that Arjo bath flexible hoses had been changed out for WRAS hoses, to be replaced on a rolling 2 year program.[295] The review advised that the shower hoses could not be shortened while maintaining clinical bath functionality; point-of-use filters were fitted instead.[296] However GGC have advised the Inquiry that the shower hoses were shortened in 2021.[297]

19.6. The IMT minutes of 3 July 2019 raised a concern about the lack of a filter in the Arjo bath in ward 6A[298]. This arose in the context of the sink outlet in that room testing positive for Mycobacteria, with its filter being thought to be defective. By way of remedial action:

> "It was agreed to take the ARJO bath out of Ward 6A. Estates will remove the bath and cap off the water outlet to the bath. This will enable the bath to be reinstated once the Paediatric ward moves out of the ward and control of it is given back to the adult sector. Karen Connelly will contact Anne Harkness to seek approval for the removal of the ARJO bath."

19.7. The water pipes were reported as capped on or around 16 September 2019.[299]

19.8. The use of Arjo baths in the hospital is a potentially deficient feature for the purposes of Glasgow III.

[294] A33870454 - DMA Canyon Water System Risk Assessment, January 2019 – Bundle in relation to Water PPP – Page 1374.
[295] A33869445 – GGC Review of DMA Recommendations, 29 January 2019 – Bundle 8 for Oral hearing commencing 12 June 2023 – Page 98.
[296] A33872975 - GGC Review of DMA Recommendations, 16 December 2018 – Bundle in relation to Water PPP – Page 852.
[297] A44311369 - Parts 1(iii), 1(iv) & 2(i) of GGC response to s.21 Notice 8 – Bundle in relation to Water PPP – Page 987.
[298] A36591628 – 03.07.2019 IMT – Bundle for Oral hearing commencing 12 June 2023 – Bundle 1 – Page 331.
[299] A37854452 - Briefing paper: Ward 6a (Haematology/Oncology) – Bundle in relation to Water PPP – Page 902; this being a draft of A37854558 - SBAR in relation to Ward 6a, 2 October 2019 – Bundle in relation to Water PPP – Page 904.

Insufficient backflow protection

19.9. Scottish Water Byelaws Inspection Reports of 28 February 2020 and 10 March 2023 insufficient backflow protection for Arjo baths across the QEUH site.[300] It is not known what remedial actions if any have been taken to address those concerns. The lack of backflow protection in Arjo baths is a potentially deficient feature for the purposes of Glasgow III.

20. Water coolers

20.1. Water coolers were supplied by third parties and installed at locations throughout QEUH. These machines supplied drinking water either via connection to the mains cold water system, or via standalone water bottles. They were identified as potentially deficient features due to concerns around the quality of water from them, which differed for each type of water cooler.

20.2. SHTM 04-01 para 8.26 advises, in respect of *'Vending, chilled water and ice-making machines'* that:

> "The water supply to this equipment should be taken from a potable supply via a double check valve to prevent backflow and be upstream of a regularly used outlet with the minimum of intervening pipe-run, that is, less than 3m. The supply should not be softened. Additionally, it should be established that the usage is sufficient to avoid deterioration in water quality, for example that the inlet water temperature does not exceed 20ºC" [301]

20.3. Water coolers were supplied by third parties and installed at locations throughout QEUH. These machines supplied drinking water either via connection to the mains cold water system, or via standalone water bottles.

20.4. On 2 March 2017 Dr Inkster issued an SBAR raising concerns about the water coolers in the following terms[302]:

> "The microbiological quality of water from coolers may be of a poor standard and therefore pose a risk to patients, particularly those who are immunosuppressed. Historically there have been concerns over maintenance and cleaning of water coolers and over who has responsibility for them"

20.5. Dr Inkster observed that draft HFS Guidance SUP 05 (Provision of drinking

[300] A43262538 - Scottish Water Byelaws Inspection Report, 28 February 2020 – Bundle in relation to Water PPP – Page 1390; A43262488 - Scottish Water Byelaws Inspection Report, 10 March 2023 – Bundle in relation to Water PPP – Page 1446.
[301] A32354164 - SHTM 04-01 Part A, July 2014 – Bundle in relation to Water PPP – Page 306. The same provision is in v1 of that guidance from August 2011 (archived July 2014).
[302] A38694868 – SBAR 2 March 2017 water coolers and risk to patients – Bundle for Oral hearing commencing 12 June 2023 – Bundle 4 – Page 93.

water) highlights NHS responsibility to protect from waterborne bacteria in drinking water and water dispensers, and advises against free standing bottled water coolers due to infection risk. The low water flow risks stagnation and proliferation of bacteria. Positioning of coolers and poor stock control may also contribute. Mains-fed coolers and standalone coolers (fed from commercially-available bottles) were both present in QEUH. Mains-fed coolers are of higher quality. Sanitisation and maintenance of those should be undertaken at least every three months.[303]

20.6. She recommended that GGC apply the draft HFS Guidance SUP 05. Mains-fed coolers and standalone coolers were to be treated differently. Any mains-fed coolers presently in high-risk areas could remain, but "may be removed if deemed an infection control risk i.e. implicated in an outbreak", with no new mains-fed coolers to be installed in such areas (with IPCT and Estates to be alerted to any new purchases). She recommended practice on their use:

> "Mains coolers should be subject to regular quarterly maintenance and weekly cleaning. Users should ensure that water is not consumed directly from the cooler and that drip trays are kept clean and dry on a daily basis. Water should not be allowed to pool as this will create stagnant conditions."[304]

20.7. Dr Inkster recommended that standalone coolers were to be almost entirely removed:

> "Stand alone water bottle coolers should be removed. The only agreed exception should be maternity USS clinics or urology clinics where patients may be required to drink water pre procedure and no mains fed cooler is in the vicinity. These coolers should be identified and a cleaning regime should be agreed with the IPCT."[305]

20.8. Water coolers appear to have been taken out of use for patients in inpatient areas at a date before 28 March 2018 (with bottled water to be provided to patients for drinking and brushing teeth),[306] though they remained in use elsewhere in the hospital.

20.9. Water coolers were removed in RHC on 26 April 2018, with further concerns to be pursued:

> "IP withdrew all water coolers from RHC on Thursday and the provision of bottle water has been arranged for the wards. A decision on the long-

[303] A38694868 – SBAR 2 March 2017 water coolers and risk to patients – Bundle for Oral hearing commencing 12 June 2023 – Bundle 4 – Page 93.
[304] A38694868 – SBAR 2 March 2017 water coolers and risk to patients – Bundle for Oral hearing commencing 12 June 2023 – Bundle 4 – Page 94.
[305] A38694868 – SBAR 2 March 2017 water coolers and risk to patients – Bundle for Oral hearing commencing 12 June 2023 – Bundle 4 – Page 94.
[306] A39123928 - Water Incident, March 2018 Updated – Bundle for Oral Hearing Commencing 12 June 2023 – Bundle 5 – Page 135.

term reallocation of the water coolers and dispensers needs to be determined. It was noted that these are part of the water system of the hospitals but are not maintained by Estates staff, they are maintained by an outside contractor which includes a 6 monthly sanitisation and service. MAK noted her concerns on the results being returned from these dispensers and their continuing use within the hospital. It was agreed that TI will forward her SBAR for comment. SD noted that there were questions being asked by nursing staff on why the coolers had been removed and it was noted that appropriate communication had not been taken forward with staff and will be resolved. OPD removal of the water coolers – there was not thought to be any reason to back fill these with bottles of water as in the wards. It was agreed that with POUF in place and ice available on the wards it would be acceptable to use the tap water for drinking. The risk to patients overrides the requirement to provide drinking water and the decision to remove the water dispensers was agreed"[307]

20.10. Work to remove water coolers remained ongoing during 2019:

"in some locations the units had been isolated but not yet removed"[308]

…

"Guidance is being issued nationally that bottled water coolers should not be used in NHS Scotland healthcare premises. This is due to the fact that there is potential for bacteria in the nozzle and the water bottle if not routinely used, which could pose an infection risk to vulnerable patients. This guidance has been issued to all Boards in Scotland who have either removed or are in the process of removing all bottled water coolers. NHSGGC is complying with this. Patients and staff will have access to drinking water from ward kitchens or suitably assessed plumbed in water coolers."[309]

…

"Standalone Bottled Water Coolers ... Management at the local level of hygiene is the issue not the actual coolers themselves but as local cleaning and maintenance is not taking place routinely across the Board it was agreed on the basis of risk that these need to be removed. Eden will continue to supply bottled water until told otherwise … Under Counter Chillers – Concerns that some models of these have reservoirs and these are a concern … Water coolers currently in place will be given the same documentation to ensure that these are cleaned and maintained appropriately and documented. Risk assessments for standalone bottled water coolers will be carried out in the areas by

[307] A38668909 – Water Technical Group Meeting 27 April 2018 – Bundle in respect of the Water Technical Group / Water Review Group Minutes in relation to the Glasgow 3 Hearings – Page 19.
[308] A38675850 – NHSGGC Board Water Safety Group Meeting 25 April 2019 – Bundle of documents in respect of the Water Safety Group in relation to the Glasgow 3 Hearings - Page 104.
[309] A34380791 – Media Statement dated 16 August 2019 – Bundle for Oral Hearing Commencing 12 June 2023 – Bundle 5 – Page 340.

exception if a chiller or a plumbed in version cannot be provided as it may be the case that there is no alternative"[310]

…

"Any increase of people drinking bottled water at the QEUH may be due to the recent removal of bottled water coolers from the site due to risk of contamination. This was in response to the potential for bacteria to grow in the nozzle and the water bottle if not routinely used, which could pose an infection risk to vulnerable patients"[311]

20.11. Pro Lp Consulting Ltd's Authorising Engineer Management and Compliance Audit dated 11 January 2023 noted:

"Some of the required LUO [Little Used Outlet] flushing is completed by DMA Canyon Ltd. Specifically, DMA Canyon Ltd flush the following:- Three times per week flushing of supply pipes to unused or removed water coolers."[312]

20.12. The use of both stand-alone and mains connected water coolers is a potentially deficient feature for the purposes of Glasgow III.

21. Dishwashers

21.1. Dishwashers were identified as potentially deficient features. These were plumbed into ward areas and connected with flexible hoses. Concern over the installation of these items identified their potential as locations for organic growth.

21.2. Concern over dishwashers was raised on 22 September 2017 in an IMT meeting regarding 'Exophiala in Cystic Fibrosis Patients':

"over the last 11 months there has been an increase in the number of patients who had this organism isolated from clinical samples, with a peak identified in August …

[Adult wards] … An engineer reviewed two of the dishwashers and the following issues were identified:-

Found to have 2 rinse aid containers in use rather than one rinse and one detergent.

Bottom filter found to have build up of residue

Found to have correct containers fitted but hoses supplying machine

[310] A38675852 –NHSGGC Board Water Safety Group Meeting 3rd September 2019 – Bundle of documents in respect of the Water Safety Group in relation to the Glasgow 3 Hearings – Page 112.
[311] A39123887 – Media Statement dated 4 December 2019 – Bundle for Oral Hearing Commencing 12 June 2023 – Bundle 5 – Page 410.
[312] A44312832 - Pro Lp Consulting Ltd Audit 2023 – Bundle in relation to Water PPP – Page 1435.

from containers were wrong way round.ie rinse aid hose was in detergent and detergent hose was in rinse aid.

In addition detergent container found to be crystallising in bottom of container resulting in uptake into hoses and on into machine. Hose intake usually sits at bottom of container." [313]

"incident from last year whereby we had noticed cystic fibrosis patients colonised with a fungus called Exophiala. It does not cause clinical infection but we decided to check dishwashers"[314]

""In 2017, Exophiala was identified in an environmental sample taken from a dishwasher. As a precaution dishwashers were removed from some areas in both the adult and children's hospital. No patients were affected."[315]

21.3. Dr Inkster and Dr Storrar addressed what further action was to be taken with respect to the dishwashers in an exchange on 7 June 2018, Exophiala having been discovered still to be present:

"… Is the plan to put on point of use filters?

yes we do … There were issues with cleaning and plumbing of these which was addressed and I reswabbed a few weeks back. The fungus is still there so I have requested online filters before swabbing again. At the moment these dishwashers are out of use in Cystic fibrosis wards until we get negative results."[316]

21.4. This is understood to be a reference to ongoing discussions in Water Review Meetings around the installation of point of use filters,[317] such as:

"**Dishwashers and Drinking Dispensers**

The question was raised at the last meeting about putting POUF on these. It was noted that these are proving difficult to locate but TI noted that there had been spores found in the dishwashers but it was unclear how this was happening. Due to the settings these are being run at with appropriate detergent there should be nothing being found. It was agreed that these should be run every day with the appropriate

[313] A41890305 – 22.09.2017 IMT – Bundle for Oral hearing commencing 12 June 2023 – Bundle 1 – Pages 50 and 51.
[314] A33820370 - Email from Dr Inkster to Dr Storrar 7 June 2018 – Bundle in relation to Water PPP – Page 842.
[315] A41501722 – Herald on Sunday article "Early fungal outbreaks at hospital revealed" – Bundle for Oral Hearing Commencing 12 June 2023 – Bundle 5 – Page 313.
[316] A33820370 - Email from Dr Inkster to Dr Storrar 7 June 2018 – Bundle in relation to Water PPP – Page 842.
[317] A44311369 - Parts 1(iii), 1(iv) & 2(i) of GGC response to s.21 Notice 8 – Bundle in relation to Water PPP – Page 978.

> detergent by catering staff and a record kept of the units and testing continues. It was noted that a realignment of the machines was carried out last week and should prevent anything further but as a precaution in the high risk areas – 7A/7D/3A/3B/3C and high risk areas (in in total) should have POUF fitted."[318]

21.5. The Inquiry is unaware as to whether these actions were carried out.

21.6. The use of dishwashers – or at least the use of dishwashers without daily cleaning – in Cystic fibrosis wards is a potentially deficient feature for the purposes of Glasgow III.

22. Energy centre

Capacity of the energy centre

22.1. The performance of the Energy Centre against its theoretical capacity prompted concerns that it may be a potentially deficient feature of the water system at QEUH. The fundamental concern was that the centre may not be capable of operating to full capacity. The risk as a consequence would be that it would thereby be unable to reliably maintain the hot water system at the temperature at which it was supposed to operate, meaning an increased risk of growth of legionella.

22.2. In 2014 the 'New South Glasgow Hospitals Specification CHP Systems' states "The primary purpose of the CHP is to provide Medium Temperature Hot Water" and "The CHP Units shall be controlled by their own controls system to provide a constant 105 °C flow." [319]

22.3. In 2019 NSS Health Facilities Scotland described the purpose of the Energy Centre at QEUH as follows:

> "To provide an efficient source of heating and power for QEUH, RCH and other parts of the QEUH campus a new separate Energy Centre was built to house the Combined Heat and Power Unit (CHP) and boilers.
>
> Hot water is distributed to the building plant rooms from the energy centres via a Medium Temperature Hot Water (MTHW) heating system derived from seven MTHW dual fuel boilers and 3 gas fired CHP units. The CHP system is designed to be the lead system and provide a high portion of the campus heating requirement.\
>
> In the QEUH and RCH plant rooms there are plate heat exchangers which convert the MTHW to Domestic Hot water (DHW) and Low

[318] A38668902 – Water Technical Group Meeting 18 May 2018 – Bundle in respect of the Water Technical Group / Water Review Group Minutes in relation to the Glasgow 3 Hearings – Page 31.
[319] A34316123 - Specification CHP Systems – Bundle in relation to Water PPP – Page 1137.

> Temperature Hot Water (LTHW) to serve the hot water and heating circuits respectively, for the wards and ancillary spaces."[320]

22.4. Capita, in their Supervisor's Final Defects Certificate dated 26 January 2017, recorded a concern regarding the operation of the Energy Centre as having been identified to them on 28 October 2016:

> "CHP control is still set back at 80 percent heat output, based on higher than expected return temperatures ... this is combine with the heat dump valve being set at 50% minimum setting, therefore the CHP is continuously rejecting 50 percent of 1 CHP output (600 KW rejection)". as a result this system cannot be operating at optimum design efficiency…
>
> … advise from Schneider installation team is that they were instructed by H&V commissioning to set the value at a minimum 50% (5V) in order to achieve the required flow rates to balance the system. This cannot be correct? Please provide commission detail to justify the current configuration against the design control philosophy? detailed review of CHP control philosophy and performance is urgently required."[321]

22.5. Capita recorded that remedial action was envisaged in the near future:

> "Boiler flow temperature now reduced and system being monitored. Edina to be arranged w/c 06/02/17 to put CHP back into 100 percent performance."[322]

22.6. On 10 May 2018 Innovated Design Solutions produced an in depth 'Forensic Analysis Report' on the QEUH/RHC Energy Centre.

22.7. GGC requested Innovated Design Solutions to undertake a forensic analysis of record documentation contained within the Zutec electronic database pertaining to the medium temperature hot water installation, providing comments with regards to probable design intent, and identifying any potential inconsistencies relative to the same.[323]

22.8. Innovated Design Solutions were also asked to review and comment on possible variations undertaken to the system that appeared to deviate from the anticipated initial design intent, together with an opinion with respect to any anomalies in relation to the same.[324]

22.9. Where there was insufficient information made available to the Innovated Design Solutions, there was some speculation in relation to particular aspects of the system. Innovated Design Solutions accepted that inaccurate opinions

[320] A33448015 – HFS Water Management Issues Technical Review – Bundle for Oral Hearing Commencing 12 June 2023 – Bundle 7 - Page 140.
[321] A32402296 - Final Defects Certificate 26.01.2017 – Bundle in relation to Water PPP – Page 1225.
[322] A32402296 - Final Defects Certificate 26.01.2017 – Bundle in relation to Water PPP – Page 1225.
[323] A33795394 - Forensic Analysis Report – Bundle in relation to Water PPP – Page 1270.
[324] A33795394 - Forensic Analysis Report – Bundle in relation to Water PPP – Page 1270.

may have been arrived at.[325]

The concerns raised in the report were:

> "….it would appear there was likely to be inherent irregularities in terms of the original MTHW heating primary circulation design philosophy. These may have subsequently resulted in system temperature control instability, and consequently led to the CHP system underachieving intended desired level of performance."[326]
>
> "….post completion/commissioning alterations were primarily instigated with a view to enhancing probable CHP underperformance. However, the eventual influences of modifications on the MTHW heating system do not appear to have been thoroughly considered prior to implementation." [327]
>
> "Alterations to the control systems included several amendments to the presumed original design intent, including functional operation parameters pertaining to CHP system, boilers, primary MTHW circulation pumps, and automatic control valve sequencing."[328]
>
> "In relation to CHP system and boiler operation, the revised strategy appears to prioritise heat rejection to atmosphere over the presumed original intent of de-rating CHP unit outputs. On the presumption the CHP system was intended to operate on heat led basis, this does not appear to be an appropriate or efficient method of operation. Furthermore, temperature set point adjustments appear to have effectively resulted in an apparent **continued rejection of heat to atmosphere**, whilst up to three boilers are operational, and again raising concern with regards to efficiency from both energy and monetary perspectives."[329]
>
> "In terms of primary MTHW pump operational modifications….. we anticipate the revised control methodology to be ineffective, thereby resulting in a significant fundamental divergence from the intended system operation in respect of primary and secondary circulation. A particular consequential effect of these pump control modifications appears to have caused **lower secondary side temperatures (i.e. heating and domestic hot water services) than those originally proposed, adversely influencing thermal comfort and increasing the risks associated with legionella."**[330]
>
> "Circulation temperatures noted…. tend to indicate the incidence of a primary MTHW circulation short-circuit, which could be a consequence of automatic control valve adjustments undertaken…. there also

[325] A33795394 - Forensic Analysis Report – Bundle in relation to Water PPP – Page 1270.
[326] A33795394 - Forensic Analysis Report – Bundle in relation to Water PPP – Page 1268.
[327] A33795394 - Forensic Analysis Report – Bundle in relation to Water PPP – Page 1268.
[328] A33795394 - Forensic Analysis Report – Bundle in relation to Water PPP – Page 1268.
[329] A33795394 - Forensic Analysis Report – Bundle in relation to Water PPP – Page 1268.
[330] A33795394 - Forensic Analysis Report – Bundle in relation to Water PPP – Pages 1268 and 1269.

appears to have been alterations made to lead plant sequence controls, and load diversion strategies, which may result **in insufficient heat generation** during periods of peak demand."[331]

'….the domestic hot water services appear to have been originally designed on the basis of direct heating utilising MTHW/DHWS plate heat exchangers, as to afford rapid recovery of domestic hot water temperatures, and minimise risks associated with legionella. Given the lower than originally intended operational temperatures observed during our investigation works, and temperatures indicated within the User Manual, the revised control strategy would appear to have resulted in the primary distribution operating on a low temperature hot water basis, and unlikely to afford rapid heat recovery.'[332]

"In conclusion…..there may well have been complications associated with the successful operation of the systems prior to implementation of system modifications. Post completion alterations do not seem to have successfully resolved recognised original system inadequacies, and appear to have created separate/additional detrimental operational problems."[333]

22.10. The 2019 Health Facilities Scotland report also records that there had been issues throughout with the Energy Centre, with the plant having been brought online late and never having been signed off as compliant with the specifications of the contract:

"The CHP plant was not commissioned within the original project timeline and was subject to contractual penalties.

A summary of the current situation (as at writing of Report) is as follows:

Intended project completion	January 2015.
Actual project completion	January 2016 All 3 CHP units were brought online, there was no sign off on the compliance of the CHP with the contract as Multiplex still required to prove the control strategy and energy performance, to date (July 2018) this has not been provided

[331] A33795394 - Forensic Analysis Report – Bundle in relation to Water PPP – Page 1269.
[332] A33795394 - Forensic Analysis Report – Bundle in relation to Water PPP – Page 1313.
[333] A33795394 - Forensic Analysis Report – Bundle in relation to Water PPP – Page 1269.

First indication not working as intended	January 2016
Date changes made to control software	These changes have been ongoing since January 2016 under the control and instruction of Multiplex, current configuration was implemented Aug 2017 by Multiplex (not proven or signed off as working).
Have all software changes been documented	No these software changes have not been documented despite requests for this documentation and sign off by the system control philosophy changes by the design engineers. Following pressure (from GGC Estates) a user guide was issued (by the Contractor) for use by the operational Estates Team

…

GGC have advised they have not been able to operate the plant as intended due to numerous failures of the system …"[334]

22.11. The HFS report also records that these issues were under discussion with the contractor, without agreement:

"The Contractor has indicated that they and their advisors can see no consistent issues with temperatures although there may be some control issues which were instigated in 2017 and it has been these changes which have caused the potential issues with the hot water temperatures at QEUH and RCH.

Temperature issues

GGC has advised that the main issue is that the MTHW flow and return temperatures are not as specified. This in turn means that on occasion that the DHW temperatures on the wards will fall below the specification and parameters set out in SHTM 04-01."[335]

22.12. The HFS report summarised the position as follows:

"As noted in DMA's reports there were issues reported at the time with the MTHW supply to QEUH and RCH from the Energy Centre. This may have contributed to the LTHW temperatures to the outlets dropping

[334] A33448015 – HFS Water Management Issues Technical Review – Bundle for Oral Hearing Commencing 12 June 2023 – Bundle 7 - Page 141.
[335] A33448015 – HFS Water Management Issues Technical Review – Bundle for Oral Hearing Commencing 12 June 2023 – Bundle 7 - Page 141.

> below the minimum 50oC required and into the legionella growth zone (which would have also aided other organism growth). There is evidence from the BMS logs that the LTHW temperature is low. This situation has not been resolved at the time of writing (July 2018). Issues with Water Management Issues Technical Review Page 78 of 124 Version V1.0 the function of the CHP are being addressed directly by GGC to the Contractor."[336] [337]

22.13. Among the recommendations were that GCC should:

> "2. Resolve outstanding issues with the Energy Centre."[338]

22.14. It is not clear whether further remedial action has been taken. In any event the question of whether the energy centre has sufficient capacity to operate the hot water system within a temperature range outside the legionella growth zone is a potentially deficient feature for the purposes of Glasgow III.

Insufficient backflow protection

22.15. Another potentially deficient feature identified in the Energy Centre was a lack of sufficient backflow protection on a filling loop and the incoming supply. Backflow protection reduces the risk of contaminated water flowing in an unintended direction through pipework.

22.16. Scottish Water Byelaws Inspection Reports of 28 February 2020 and 10 March 2023 identified instances of insufficient backflow protection on a filling loop and the incoming supply to the Energy Centre Building.[339] It is not known what remedial actions if any have been taken to address those concerns. The lack of backflow protection in the Energy Centre is a potentially deficient feature for the purposes of Glasgow III.

23. Irrigation system

23.1. The irrigation system operated as an external soakaway irrigation system in various courtyards and rooftop gardens at the QEUH site. This system was identified as a potentially deficient feature due to its less-frequent use, and

[336] A33448015 – HFS Water Management Issues Technical Review – Bundle for Oral Hearing Commencing 12 June 2023 – Bundle 7 - Pages 146 and 147.
[337] NB that the reference to the DMA Report may be a reference to DMA having recorded in its 2015 Report that: *"When DMA were on site on the 21st of April there was a significant drop on the temperatures of the calorifiers which we understand was caused by a failure on the heating system. Temperatures recorded on these calorifiers on this day were 40-45°C."* [A33870103 – DMA L8 Risk Assessment, 1 May 2015 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 220.]
[338] A33448015 – HFS Water Management Issues Technical Review – Bundle for Oral Hearing Commencing 12 June 2023 – Bundle 7 - Page 148.
[339] A43262538 - Scottish Water Byelaws Inspection Report, 28 February 2020 – Bundle in relation to Water PPP – Page 1390; A43262488 - Scottish Water Byelaws Inspection Report, 10 March 2023 – Bundle in relation to Water PPP – Page 1446.

distance from the rest of the system, posing a risk that it may function as a deadleg, with consequent risks of stagnancy and growth of organic material.

23.2. In its gap analysis of 8 March 2016, DMA Canyon raised the concern that, subsequent to earlier recommendations on flushing, the irrigation system had instead been disconnected, leaving the possibility of deadlegs:

> "**Irrigation System**
>
> Task
>
> Include in site flushing regime. Additional flushing may also be required (outlets run for extended periods) to bring temperatures on distribution system down particularly during periods of low use (e.g. in winter when irrigation system is not required to operate frequently). Maintain in accordance with manufacturers/installers instructions
>
> Minimum Frequency
>
> Twice weekly as part of site flushing regime
>
> In place or being carried at present?
>
> This is not being carried out at present. Allocation of responsibilities unclear at this time. These should be formally included in site flushing regime."[340]

23.3. Subsequent to the Gap Analysis, flushing was carried out though not on a twice-weekly basis. Ten flushing events were recorded from 3 May 2016 to 29 November 2019.[341]

23.4. GGC record that in February 2017 the disconnection/removal work was carried out:

> "Irrigation system for external vegetation/planting was isolated and disconnected and external bb taps removed [because] identified as an unnecessary risk"[342]

23.5. It is inferred that this was pursuant to an instruction made on 30 December 2016 to "Isolate outside taps in garden areas if possible", and marked completed by 24 February 2017.[343]

23.6. On 30 January 2018, DMA Canyon maintained its concern regarding the possible presence of deadlegs in the residual irrigation system:

[340] A44312702 - DMA Gap Analysis, 8 March 2016 – Bundle in relation to Water PPP – Page 1215.
[341] A33869858 - 'Item 487 – Irrigation FM first tickets' – Bundle in relation to Water PPP – Page 1221.
[342] A44311369 - Parts 1(iii), 1(iv) & 2(i) of GGC response to s.21 Notice 8 – Bundle in relation to Water PPP – Page 980.
[343] A33869865 - 'Item 487 – Irrigation System comments' – Bundle in relation to Water PPP – Page 1363.

> "Comments Very long runs to outlets through the building.
>
> Recommendations Ensure former connection points are included in site flushing regime or removed leaving no deadlegs with stored capacity reduced as required."[344]

23.7. The Water Management Issues Technical Review produced by HFS in March 2019 also stated that while outlets for the irrigation system had been removed, the pipe work serving them had not been completely removed.[345]

23.8. The inclusion of an Irrigation system for external vegetation/planting is a potentially deficient feature for the purposes of Glasgow III.

24. Waste system

24.1. The waste system at QEUH was a possible location of interest during an incident regarding the water system in 2018, where investigation was being made into the source of a series of infections in certain wards in RHC.

24.2. Multiplex have submitted to the Inquiry the document 'Description of Above Ground Drainage', which describes the drainage system within QEUH in the following terms:

> "This description relates to the above ground drainage system serving the Adult and Children's Hospitals at the time it was handed over to GGHB by MPX.
>
> …
>
> Above ground foul (soil and waste) drainage is collected from sanitary fittings, equipment and outlets, by a system of vertical and horizontal pipework distributed within the building, to connect to the below ground drainage system.
>
> …
>
> The drainage system operates under gravity with anti-siphon ventilation stacks to atmosphere for the ground floor upwards.
>
> …
>
> For the basement, the soil and waste feeds into a sump located in the pump room FMB-024 and is pumped into the ground floor and below

[344] A33870243 – DMA Canyon L8 Risk Assessment, Final Submission 25 April 2018 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 585.
[345] A33448015 – HFS Water Management Issues Technical Review – Bundle for Oral Hearing Commencing 12 June 2023 – Bundle 7 - Page 84.

ground drainage system."[346]

24.3. During the series of IMT meetings on the 2018 Water System Incident concerns were raised regarding drains as a potential source of the Enterobacter clocae outbreak Healthcare Infection, Incident and Outbreak Reporting Template, 29 May 2018. Other potential sources, including cleanliness, large numbers of visitors, and presence of large amounts of patient and parent belongings, had been raised at previous meetings:

> "A PAG was held on 18.05.18 to assess 4 cases of Enterobacter cloace bacteraemia associated with wards 2A or 2B
>
> …
>
> Yesterday ([redacted].05.18) a further Enterobacter cloacae bacteraemia was confirmed. This patient was non HAI by definition but [redacted] too had had contact with ward 2B. Typing of 2 cases also found both patients to have unique strains. Typing results are awaited for the others. An IMT was held today 29.05.18. All the above actions were reviewed and noted to have been completed. The following additional actions were agreed:
>
> Drains within clinical hand wash basins to be swabbed on ward 2A and 2B
>
> Request to be made to facilities to clean all drains in 2A and 2B following swabbing…"[347]

24.4. The swabs taken as a result of that meeting were analysed and the results addressed at a subsequent IMT meeting on 4 June 2018: Water System Incident Ward 2A & 2B.

> "A Problem Assessment group was held on the 18th May 2018 to discuss 4 new cases of E.cloacae bacteraemia and 3 cases of Stenotrophomonas maltophilia bacteraemia in patient's associated with ward 2A and/or 2B. A number of actions were generated from these PAGs including sampling of drains. Late on Friday, results of the drain swabs were reported. Various gram negative organisms were indentified including Enterobacter cloacae, Paeusomonas aeruginosa, Sphingomnas, Cupriavadis pauculus, Acinetobacter ursingii and Klebsiella oxytoca.
>
> …
>
> Dr Inkster expanded on the findings of the drain swabs … it is very likely that the Enterobacter cloacae bacteraemias are associated with contaminated drains … AR queried if concerns had been reported

[346] A44674683 - 'Description of the Above Ground Drainage' – Bundle in relation to Water PPP – Pages 1000 and 1001.
[347] A41967195 - HIIORT 29 May 2018 – Bundle in relation to Water PPP – Pages 840 and 841.

> relating to drains previously. AH and SD stated that black grime had been noted in the drains some weeks ago. AG confirmed that this had been reported and discussed at previous water IMTs. He stated that the opinion of both water experts consulted as part of the water incident was that drains should not be cleaned. AR advised that this advice is approached with caution."[348]

24.5. It was agreed that the drains should be cleaned:

> "IP reported that following a request for drains to be cleaned on Friday, he has notified Scottish water of the requirement to do so. IP informed the group that this is necessary before cleaning can be undertaken. He has also looked at appropriate products for use and circulated suggestions by email. Products include chlorine dioxide for the initial drain cleaning decontamination followed by acetic acid for ongoing rolling programme of drain cleaning. TI supported this. Ian Storrar also supported this. It was agreed that all outlet drains will be decontaminated within ward 2A and 2B."[349]

24.6. Measures to be taken in response included restricting patient access to wards 2A and 2B, undertaking drain cleaning imminently, and checking and increasing filtering[350]. Additional requirements were imposed regarding hand hygiene and antibiotic prophylaxis[351]. An infection timeline produced by the Oversight Board stated that drains were cleaned and then decontaminated with Hydrogen Peroxide Vapour in Wards 2A, 2B, 7A, 7D, PICU and elsewhere on site. The timeline also noted that, around this time, dissection of a sink waste pipe showed exposed metal parts with bio-film. All waste pipes were replaced in Wards 2A/4B with new plastic ones.[352] On Monday 4 June 2018 GGC issued a media statement containing the following:

> "Our facilities team is today carrying out treatment on the drains within Wards 2A/B after traces of bacteria were found during testing.
>
> …
>
> Our infection control experts believe the bacteria to be linked to an earlier issue with taps which have since been fitted with filters. The water supply is unaffected.
>
> Dr Teresa Inkster, NHSGGC Consultant Microbiologist, said: "As the

[348] A36690448 – 04.06.2018 IMT – Bundle for Oral hearing commencing 12 June 2023 – Bundle 1 – Pages 94 and 95.
[349] A36690448 – 04.06.2018 IMT – Bundle for Oral hearing commencing 12 June 2023 – Bundle 1 – Page 96.
[350] A36690448 – 04.06.2018 IMT – Bundle for Oral hearing commencing 12 June 2023 – Bundle 1 – Page 96.
[351] A36690448 – 04.06.2018 IMT – Bundle for Oral hearing commencing 12 June 2023 – Bundle 1 – Page 96.
[352] A33448013 – Oversight Board Infection Timeline - Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 943.

> wards affected treat patients whose immune system is compromised we have taken these immediate steps to apply a chemical disinfection to the drains and to inform the families of the situation.""[353]

24.7. On 11 July 2018 Intertek issued a report containing the following concerns in respect of wards 3A and 3C:

> "Ward 3C … Rubber seal showed evidence of significant decomposition. Heavy biofilm presence … large piece of clear plastic (50mmX40mm) … large clumps of tangled hair present … gap between down pipe and bulb trap heavily soiled to 10mm depth
>
> …
>
> Ward 3C … light staining inside the bulb trap … single piece of physical debris present in the trap (5p piece)"[354]

24.8. The difference between the two wards was apparent from the test results. In respect of Ward 3C:

> "Microbiological assessment of this debris was not deemed possible due to the expected high levels it would not be possible to obtain a dilution high enough to produce a workable result and when dealing with waste water systems with high levels of contamination the associated risk to the lab from potential virus contamination would be to great … Due to the level of contamination a traditional swabbing method of the drain was not seen as practical. On assessment it was decided that due to the seal being in a failed condition that a swab would be taken from the metal fitting where the seal attaches. The tip of a swab was dabbed onto an area of 10mm2 to perform the test. The result for the swab test gave a result of 210cfu at 6 dilutions. This would give and estimated total organism count of 210x106 /cm2 of the metal fitting"[355]

24.9. And in respect of Ward 3A:

> "The drain showed little or no evidence of contamination. All seals were intact and sound … A swab was taken from a sweep of the inside of the bowl trap the result for the swab test gave a result of 115cfu at 5 dilutions giving an estimated total count of 115x105. At this point it is worth noting the difference in organism levels between the two drain swab samples …"[356]

[353] A38661975 – GGC Media Statement 4 June 2018 – Bundle for Oral Hearing Commencing 12 June 2023 – Bundle 5 – Page 139.
[354] A33795375 – Intertek report 11 July 2018 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 638.
[355] A33795375 – Intertek report 11 July 2018 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Pages 643 and 644.
[356] A33795375 – Intertek report 11 July 2018 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Pages 644 and 645.

24.10. It is not known to the Inquiry whether any further action was taken.

24.11. In the IMT meeting of 13 September 2018, further concerns were raised in respect of ward 2A, regarding Gram Negative Bacteraemia:

> "the IMT are currently focussing on cases 18-22 and three patients have been discharged home. [redacted] Serratia has not been included in the list of organisms to date as it had not been identified in drains however after this patient had been admitted the drain in [redacted] room had been swabbed and was positive for Serratia, Teresa said we may be over reporting regarding this patient but the patient does now meet the agreed case definition. Teresa explained that is it not possible to determine what was contaminated first, patient or drain. She explained that drains are not sterile but that there should not be reflux back up into sinks.
>
> …
>
> there was a spike earlier in the year which related to the drains, then no cases were identified in June and July and then another spike now relating to the drains
>
> …
>
> It was noted that there were differences in the adult hospital compared to the children's hospital with no reflux materials found in any of the sinks in the adult hospital … alerted to a drain issue when nursing staff noticed black material coming up from the sink
>
> …
>
> we are not trying to sterilise the drains but to try and reduce the material coming up and figure out why this is happening"[357]

24.12. The timeline produced by the Oversight Board notes in addition for this period:

> "Drains swabbed in Ward 2A on 29 Aug as thick black and yellow grime visible after cleaning only 4-6 weeks ago - findings are that 2 of 3 cases match the patients. Tests show Coliforms, Delftia acidovarons, Chryseomonas indologenes, Cupriavadis, Pseiudomonas aeruginosa and Klebsiella oxytoca.
>
> "…IPCT conduct physical inspection of drains and sinks and note some appear to have sealant in the drain and black gunge is noted. Reported to F&E team who confirm sealant is a gasket in the drain that has become porous due to the use of hydrochloride cleaning products.
>
> "… Drain survey and ventilation survey are commissioned. The drain

[357] A36629307 – 13.09.2018 IMT – Bundle for Oral hearing commencing 12 June 2023 – Bundle 1 – Pages 160 and 161.

survey did not find any issues."[358]

24.13. Investigations, cleaning and decanting of patients into other wards occurred over subsequent weeks.[359]

24.14. The timeline produced by the Oversight Board noted for November 2018:

> "Following a PAG held on 25 October an IMT was set up on 2 Nov to investigate 5 cases of PsA [Pseudomonas Aeruginosa] isolated from patients who had all had appendectomies in same theatre in October 2018…Sample of drains found PsA growth in the anaesthetic trough and this was sent for typing. Excessive amount of debris, including nail picks, found in u-bend traps of drains also. All drains throughout theatre have been cleaned. No further meetings were planned unless new cases identified."[360]

24.15. The Oversight Board timeline narrates further instances of drains harbouring concerning bacteria and excessive amounts of debris.[361] In all instances the drains were cleaned however the current state of the hospital's drainage is not known.

24.16. A report produced for a Clinical Care & Governance meeting of 5 December 2017 stated:

> "Plumbing in Neuro Surgical Block
>
> Dr Redding stated that there has been sewage leaking in the theatre suite since before 2015 and is still ongoing and not all incidents have been reported to ICDs [Infection Control Doctors]"[362]

24.17. An appended action plan noted for this concern:

[358] A33448013 – Oversight Board Infection Timeline - Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 945.
[359] A36629309 – 14.09.2018 IMT – Bundle for Oral hearing commencing 12 June 2023 – Bundle 1 – Page 164.
A36629315 – 17.09.2018 IMT – Bundle for Oral hearing commencing 12 June 2023 – Bundle 1 – Page 169.
A36629310 – 18.09.2018 IMT – Bundle for Oral hearing commencing 12 June 2023 – Bundle 1 – Page 175.
A36629316 – 19.09.2018 IMT – Bundle for Oral hearing commencing 12 June 2023 – Bundle 1 – Page 180.
A36629320 – 20.09.2018 IMT – Bundle for Oral hearing commencing 12 June 2023 – Bundle 1 – Page 185.
A36629324 – 25.09.2018 IMT – Bundle for Oral hearing commencing 12 June 2023 – Bundle 1 – Page 190.
[360] A33448013 – Oversight Board Infection Timeline - Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 947.
[361] A33448013 – Oversight Board Infection Timeline - Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Pages 949, 951 and 956.
[362] A32347779 - Report on Concerns Raised re QEUH and RHC – Bundle in relation to Water PPP – Page 836.

"Ensure reporting is ongoing."[363]

24.18. It is not known what if any further action was taken.

24.19. It should be noted that drains are not sterile, that there is no systematic survey of the waste system and there is no analysis that answers the question of what was contaminated first during the investigations described in this section; patient or drain. However given the interest shown in the drains as part of those investigations, the waste system is a potentially deficient feature for the purposes of Glasgow III.

25. Conclusion

25.1. This Paper has identified many potentially deficient features for the purposes of Glasgow III. Notwithstanding the sources used to identify these features the question of whether system as a whole or in part (a) did or does not achieve the outcome or was capable of the function for which it was intended, or (b) did or does not conform to relevant statutory regulation and other applicable recommendations, guidance, and good practice will be determined after evidence is heard at the Glasgow III hearing. The same statement is also true for the key concept in the Key Questions of whether the whole or part of the water system (including drainage) was or remains in an unsafe condition, in the sense that that feature presented or presents an additional risk of avoidable infection to patients. These questions will require to be determined only after evidence has been led and submissions received in the Glasgow III hearing.

25.2. It seems clear to the Inquiry team that some of the potentially deficient features identified in this Paper appear to only apply to discrete parts of the system whilst others are potentially system wide. Some of these potentially deficient features are literal physical features of the system and some are aspects of its operation or, in some way, results of testing or investigation that appear to or could apply to all or a large part of the water in the system. The consideration of the effect of these potentially deficient features in Glasgow III must look at these features in isolation, in combination with others and also as a whole water and drainage system.

[363] A32347779 - Report on Concerns Raised re QEUH and RHC – Bundle in relation to Water PPP – Page 829.

SCOTTISH HOSPITALS INQUIRY

Provisional Position Paper 12

Potentially Deficient Features of the ventilation system of the Queen Elizabeth University Hospital And the Royal Hospital for Children

Contents

GLOSSARY

ADB	Activity Database
AHU	Air Handling Unit
BIW	Building Information Warehouse
BMT	Bone Marrow Transplant
BREEAM	Building Research Establishment Environmental Assessment Method
CBU	Chilled Beam Units
COS	Clinical Output Specification
HAI-SCRIBE	Healthcare Associated Infection System for Controlling Risk in the Built Environment
HBN	Health Building Note
HEPA	High-Efficiency Particulate Air Filters
HPS	Health Protection Scotland
HTM	Health Technical Memorandum
IPC	Infection Prevention and Control
ICT	Infection Control Team
M&E	Mechanical and Electrical
NHS	National Health Service
NHSEI	NHS Improvement
GGC	NHS Greater Glasgow & Clyde
PMI	Project Manager Instruction
PPVL	Positive Pressure Ventilated Lobby
RHC	Royal Hospital for Children
RDD	Reviewable Design Data
RDS	Room Data Sheet

RFI	Request for Information
SBAR	Situation Background Assessment Recommendation
SHFN	Scottish Health Facilities Note
SHTM	Scottish Health Technical Memorandum
SHPN	Scottish Health Planning Note
SHTN	Scottish Health Technical Note
TCT	Teenage Cancer Trust
QEUH	Queen Elizabeth University Hospital

1. Purpose of the PPP

1.1 This PPP has been produced to assist the Chair in addressing the terms of reference in respect of the built environment of the Queen Elizabeth University Hospital/Royal Hospital for Children as it relates to the ventilation system.

1.2 On 13 December 2023 the Chair issued Direction 5 and indicated his intention that the Inquiry should answer four Key Questions by leading evidence at the Glasgow III hearing due to commence on 19 August 2024 so that those Key Questions can be answered using that evidence along with the evidence from the hearing in the autumn of 2021 ("Glasgow I"); the hearing in the summer of 2023 ("Glasgow II"); all relevant Provisional Position Papers (PPP); and the evidence led in respect of ventilation principles and practice at hearings of the Inquiry in respect of Royal Hospital for Children and Young People/Department of Clinical Neurosciences.

1.3 As is explained in part 4 of Direction 5 this necessarily involves two important stages in respect of the ventilation system. Firstly, it is necessary to understand what features of the ventilation systems require to be considered by the Inquiry and secondly to determine the extent to which any such feature is or was in an unsafe condition, in the sense that that feature presented an additional risk of avoidable infection to patients.

1.4 The Inquiry is aware that within the construction contract between Greater Glasgow Health Board ("GGC") and Multiplex Construction Europe Limited ("Multiplex")("the Contract"), the word "Defect" is a defined term. The definition of a Defect in the Contract is different from the concept that is addressed in the Key Questions. It should be noted that a separate PPP will be produced later in the first half of 2024 which will analyse the Contract to the extent that it is necessary to answer the Inquiry's Terms of Reference.[1]

1.5 To ensure clarity at the first stage of this process the Inquiry will need to decide

[1] Clause 11.2 (5) of the Contract defines a "Defect" as: a part of the *works* which is not in accordance with the Works Information or a part of the *works* designed by the *Contractor* which is not in accordance with the applicable law or the *Contractor's* design which the *Project Manager* has accepted. This document is not produced with this PPP.

whether any particular feature of the ventilation system of the hospital is or was unsafe in the sense that the feature presented an additional risk of avoidable infection to patients and as such can be identified as a "potentially deficient feature". It is those "potentially deficient features" that the Inquiry will consider.

1.6 This PPP comes after the Inquiry heard evidence in respect of the principles and practice of hospital ventilation in the hearing commencing 9 May 2022 which was the subject of closing submissions from Counsel to the Inquiry on 7 June 2023. This PPP builds on those closing submissions, and they are ultimately the source of certain elements in the text. Where that is the case an appropriate footnote directs the reader to those submissions ("CSCIE").

1.7 This PPP sets out the Inquiry team's preliminary identification of those "potentially deficient features". The question of whether those "potentially deficient features" were in an unsafe condition, in the sense that that feature presented an additional risk of avoidable infection to patients will require to be determined only after evidence has been led and submissions received in the Glasgow III hearing.

Wards considered in this PPP

1.8 The wards at the QEUH/RHC covered in this PPP are as follows:

(i) General Wards (including Level 5 – Infectious Diseases and Level 7 – Respiratory) (QEUH)[2]

(ii) Ward 2A - Haematology and Oncology and Teenage Cancer Trust (TCT)

(iii) Ward 2B - Paediatric Haematology and Oncology – Day Care Unit (RHC)

(iv) Ward 4B - Bone Marrow Transplant (BMT) (QEUH)

(v) Ward 4C - Haemato-oncology & Renal (QEUH)

[2] Note Level 5 (Infectious Diseases) and Level 7 (Respiratory) were designed as general wards. See paragraph 6.3 of this PPP.

(vi) Ward 6A - Decanted location of the Schiehallion Unit (QEUH).

1.9 This PPP:

- attempts to identify which features of these wards did not or do not now conform to relevant statutory regulation and other applicable recommendations, NHS Guidance, and good practice by reference to those standards,
- considers relevant aspects of the contractual requirements relating to the ventilation system,
- considers relevant derogations that were agreed between the parties to the Contract up to handover of the project to GGC,
- the completed state of the ventilation system in 2015,
- any changes to the ventilation system since then and the current state of the system,
- the position in relation to commissioning and validation, and
- annual verification.

1.10 It is intended that a supplemental PPP will be produced later in the first half of 2024 which will carry out the same exercise for Paediatric Intensive Care Unit (PICU) (RHC), Ward 2A (Paediatric Bone Marrow Transplant (BMT) Unit (8 isolation rooms), the High Dependency Unit and Level 1 Critical Care Isolation Rooms (ICU) (QEUH).

1.11 Any feature of the wards set out in this PPP that does not appear to conform to the statutory regulation and other applicable recommendations, guidance, and good practice should be considered for the purposes of the Inquiry to be a “potentially deficient feature’ and is identified as such. It should be emphasised that identification of a “potentially deficient feature” and consideration of the question of its effect on patient safety are separate and distinct steps, and that inclusion of a feature in this PPP does not mean that the Inquiry has decided that the feature is

unsafe. That is a question for determination by the Inquiry after the conclusion of the Glasgow III hearing.

Procedure to be adopted

1.12 The Chair is likely to be invited to by the Inquiry team to make findings in fact based on the content of this PPP. Any Core Participant or any other person holding relevant information is invited to seek to correct and/or contradict any material statement of fact which it considers to be incorrect and to point to what evidence exists to support the position taken by the Core Participant or other person. It follows that the Inquiry's understanding of matters set out in this PPP may change and so this paper is provisional.

1.13 As explained in Direction 5, in order to focus the Glasgow III hearing on features that require to be considered in order to answer the Key Questions, Core Participants are invited to respond to this PPP within three weeks of its publication on the Inquiry website and to direct themselves to answer four questions:

1. Whether the description of the ventilation system contained within the PPP is accepted as being correct and if there are points in respect of which the Core Participant challenges the description of the system, specifically what the points of disagreement are and what evidence exists to support the position taken by the Core Participant;

2. Whether the description of any potentially deficient feature is accurate notwithstanding that the Core Participant may not accept that the feature described is potentially deficient or deficient in any sense;

3. Where the PPP describes the date or dates upon which a potentially deficient feature became known to a particular person or organisation whether the Core Participant accepts that date of knowledge or offers an alternative date notwithstanding that the Core Participant may not accept that the feature described is potentially deficient or deficient in any sense; and

4. Whether there are any other features of the ventilation system which should be considered by the Inquiry to be potentially deficient features and what evidence

exists to support that conclusion.

1.14 Subsequent Inquiry hearings may touch on some of the matters to a varying extent contained within this PPP but they may not; if parties wish to address the issues dealt within in this PPP then they are invited to do so now. In the absence of a response on a matter, the Chair is likely to be invited by the Inquiry team to make findings in fact based on the content of this PPP.

1.15 Please be aware that all responses to this PPP received by the Inquiry will be published on its website as soon as possible after the deadline for responses has passed.

2. Ventilation Tables for Relevant Wards

2.1 This PPP has a PPP12 Ventilation Table in Appendix 2 setting out the relevant features of each of the Relevant Wards. Each ward table has the same colour coding which identifies the source of the information contained in the column as follows:

- contractual ventilation sources – Green;
- NHS Guidance – Orange;
- GGC Information/Remedial Works – Blue;
- SBARS – Yellow; and
- West of Scotland Beatson Oncology Centre – Grey.

2.2 The contractual ventilation sources are described in part 3 of this PPP. A full list of NHS Guidance relevant to ventilation is listed in Appendix 1 of this PPP.

2.3 Moving from the list of the relevant features to the right, there are various colour coded column headings which relate to the colour criteria set out above. The columns are in chronological order with the earliest period in time being on the left and the most recent on the right. The green COS column will in most wards be the earliest column on the left, followed by the M&E Clarification Log (2010 ItP) Final

and related Logs and Derogations. The next two orange columns contain the specific NHS Guidance relevant to the ventilation system at the time. In relation Ward 4B there is a grey column showing the features that the West of Scotland Oncology Centre has in order to compare it with the QEUH/RHC. Finally, the two blue columns show firstly whether the key ventilation features were installed at handover in 2015 and secondly if they are installed in 2024. Further below there are two rows that show whether commissioning and validation was carried out in that specific ward.

3. Contractual context

3.1 Whilst a separate PPP will analyse the Contract to the extent that it is necessary to answer the Inquiry's full terms of reference, in order to identify features of the ventilation system that are potentially deficient features for the purpose of Glasgow III some reference must be made to some of the contractual documents in this PPP, namely:

- Volume 2/1 Employer's Requirements, with relevant Clinical Output Specifications from Appendix B;
- Contract Data Part One, Appendix 5;
- The M&E Clarification Log (2010 ltP) Final.

3.2 In addition to the above key contractual documents, a wide range of documents containing information about the features of the ventilation system are referred to within the Contract which include:

Clinical Output Specification (COS)

3.3 A COS was a document prepared by clinical staff and NHS Greater Glasgow and Clyde (GGC) staff who have expertise in the relevant ward, on what to install in that specific ward. These include the COSs for Haemato-oncology NCH (for RHC); Haemato-oncology NSG (for Adult Haemato-oncology in QEUH); and Generic

Wards[3] It should be noted that no COS was ever prepared for the BMT Unit.

External design and construction standards

3.4 NHS Guidance has been evolving over many decades[4] with certain guidance being superseded completely (for example, the SHTM 03-01 series superseded the SHTM 2025 series in February 2013[5]) while other guidance was updated so there were more recent versions (for example, the SHTM 03-01 issued in 2013 was subsequently revised and reissued in 2014 and then again in February 2022).

3.5 The NHS Guidance includes the following types of guidance:

- Scottish Health Technical Memoranda (SHTM): These 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[6].

- Scottish Health Facilities Notes (SHFN): These give comprehensive guidance on the operation of healthcare facilities. The topics within the group of guidance includes infection prevention and control, cleaning services frameworks, security, and health and safety[7].

- Scottish Health Planning Notes (SHPN): These give comprehensive guidance on the operation of healthcare facilities. The topics within the guidance include planning for in-patient facilities for both adults and children, accident and

[3] COS for NSGACL Generic Wards NSG_iss1_rev; COS for NSGACL Haemato Oncology NSG_iss1_rev; COS for NSGACL Haemat-Oncology NCH_iss1_rev.
[4] Statement of Edward McLaughlan, paragraph 6, page 3, for Edinburgh Hearing on 9 May 2022. See also Statement of Andrew Poplett, para 9, at p. 5.
[5] Note that the Draft for Consultation SHTM 03-01 Part A Design and Validation was produced in March 2009 and fell within the NHS Guidance applicable at the time of the contract. The final approved and published version of the draft guidance applied from February 2013.
[6] Statement of Edward McLaughlan, paragraph 16, page 6, for Edinburgh Hearing on 9 May 2022.
[7] Statement of Edward McLaughlan, paragraph 16, page 6, for Edinburgh Hearing on 9 May 2022.

emergency facilities, and isolation facilities[8].

- Scottish Health Technical Notes (SHTN): These provide comprehensive guidance on a range of healthcare specific standards, policies and current best practice[9].

- Health Building Notes (HBN)[10]: These provide best practice guidance on the design and planning of new healthcare buildings and on the adaptation or extension of existing facilities[11].

- Health Technical Memoranda (HTM[12]): These provide guidance for anyone involved in the design, installation or operation of healthcare ventilation. Their primary focus is as engineering technical documents but they include contributions from not only engineers, but also infection prevention control specialists and manufacturers[13].

3.6 An NHS body procuring a new hospital must develop a project brief that should ordinarily specify that the design and build is in compliance with the above NHS Guidance[14]. However, derogations from the guidance documents may be agreed at the time of the contract[15]. The requirements of NHS Guidance are the fundamental starting block of any hospital design[16]. They are the best practice guidance for hospital design[17].

3.7 There are legitimate and sound reasons why contractual parties may decide to derogate but the derogation should be assessed, and the implications considered[18]. The derogation from NHS Guidance should be fully documented

[8] Statement of Edward McLaughlan, paragraph 16, page 6, for Edinburgh Hearing on 9 May 2022.
[9] Statement of Edward McLaughlan, paragraph 16, page 6, for Edinburgh Hearing on 9 May 2022.
[10] HBNs are derived from NHS Improvement in England but approved by Health Facilities Scotland for use in Scotland. To be clear, unlike the other guidance notes, there is no separate Scottish document.
[11] Statement of Edward McLaughlan, paragraphs 16 and 17, pages 6 and 7, for Edinburgh Hearing on 9 May 2022.
[12] This is a document applicable only in England and Wales but the Scottish SHTM is based on this. The HTM was included in the NHS Guidance and applied to the QEUH and RCH on a contractual basis.
[13] Statement of Andrew Poplett, paragraph 8 at p.4. and paragraph 65 at p. 29.
[14] Bundle 6, Expert Report of Stephen Maddocks, at p.16 (Bundle p.68)
[15] Bundle 6, Expert Report of Stephen Maddocks, at p.16 (Bundle p.68)
[16] Bundle 6, Expert Report of Stephen Maddocks, at p.16 (Bundle p.68)
[17] Bundle 6, Expert Report of Stephen Maddocks, at p.18 (Bundle p.70)
[18] Oral evidence of Andrew Poplett, Hearing on 10 May 2022, at p.121 and p.122.

and recorded in the project file and the record maintained for the life of the building[19]. A derogation from NHS Guidance that could impact on patient or staff safety should never be undertaken[20].

Statutory Compliance

3.8 The ventilation system in the relevant wards also required to comply with statutes and regulations[21].

3.9 The *Health and Safety at Work etc Act 1974* is one of the statutes that falls within the list in the Employer's Requirements and is relevant given that the ventilation system is intended to prevent contamination, closely control the environment, dilute contaminants and contain hazards[22].

3.10 The ventilation system must also comply with the *Building (Scotland) Regulations 2004*. Building Standard 3.14 covers ventilation and states that:

> "Every building must be designed and constructed in 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[23].

3.11 In accordance with the Scottish Building Standards, the minimum mechanical ventilation requirement for an occupied space is to provide an average eight litres of fresh air per person per second[24]. There is no further specification in the Scottish Building Standards as to the air quality for a building such as a hospital.

The Design Process

3.12 For context, it is necessary to refer to some design documents and processes. A short summary of key documents and processes is provided in this section for

[19] Oral evidence of Andrew Poplett, Hearing on 10 May 2022, at p.122.
[20] Oral evidence of Andrew Poplett, Hearing on 10 May 2022, at p.123.
[21] Employer's Requirements, Section 5.0 (General Design and Construction Requirements) [Additional Guidance] paragraph 5.1.4
[22] CSCIE at para 43.
[23] CSCIE, para 44.
[24] Section 3.14.5 Mechanical Ventilation, Environment (Non-domestic buildings, Technical Handbook 2017).

context purposes only.

The Activity Database (“ADB”) system is standardised hospital design tool used by the NHS in the UK. It is a digital database of hospital design information including detailed requirements for clinical spaces in hospital It can be used to create a Room Data Sheet (“RDS”). Every room in a hospital project will have its own individual RDS that captures the fundamental elements (number of sockets, ventilation air change rate, provision of fire alarm etc)[25].

The ventilation parameters appear on a RDS for the room environmental data along with others such as lighting and noise parameters. When RDS are generated from the ADB, the ventilation parameters will in most cases be derived from HTM 03-01 Part A (2007).

To facilitate communication about environmental parameters, engineers devised an Environmental Matrix[26]. This is a spreadsheet which gathers together in one place, for all rooms in a building, certain parameters bearing upon its mechanical and electrical engineering systems.

The Contract contained a process for the review of certain design deliverables such as clinical functionality, specifications including finishes, colour schemes, materials and components referred to as Reviewable Design Data (“RDD”).

Changes and Derogations

3.13 The M&E Clarification Log (2010 ItP) – Final is an important record of changes, derogations and clarification and as approved takes precedence over both the Employer’s Requirements and the Contractor’s Proposals in respect of the items contained in the log[27].

3.14 The Contract had several logs to record derogations from the original scope during the build phase, but the ‘M&E Clarification Log (2010 ItP) – Final’ document which is referred to in this PPP ultimately recorded the agreed derogations at

[25] CSCIE, at para 68
[26] CSCIE, at para 72.
[27] Contract Data part one of the Contract, Appendix 5.

handover[28] and is used for the purposes of this PPP to assist in identifying whether key features are present or absent at handover. An excerpt from the M&E Clarification Log (2010 ItP) – Final concerning the agreed derogation of ACH is set out in Appendix 4 of the PPP.

Commissioning & Validation

3.15 The HTM-03 Part A (2007) states at page 80 that 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."

3.16 Commissioning is setting to work the ventilation system to make sure it is balanced, and the individual components function as they are designed[29].

3.17 Furthermore, the HTM-03 Part A (2007) states at page 66 that validation is:

> "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 the 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."

3.18 HTM-03 Part A (2007) goes on to state at page 66 that:

> "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 Authorised Person appointed by the client."

3.19 Validation is a process where, usually an independent company, checks that all

[28] Contract Data part one of the contract, Appendix 5.
[29] Oral Evidence of Andrew Poplett, Hearing on 10 May 2022, at p.112.

the components work together (for example, the fire alarm system and the ventilation system) once the construction has been completed. Validation is usually offered before practical completion and completed after practical completion [30].

3.20 Any non-compliance with the Draft for Consultation SHTM 03-01 Part A (2009) noted by the independent third party would be flagged up to the NHS body[31]. However, in a PMI in July 2013, GGC agreed that the independent commissioning engineer under the Contract could be staff from Multiplex[32]. The Inquiry team have been unable to locate any specific contractual provisions in the Employer's Requirements for the validation of ventilation equipment in the QEUH/RHC contract documents. It is not known if this reflected standard or accepted practice at the time. However, there is a validation process set out within Draft for Consultation SHTM 03-01 Part A (2009)[33].

3.21 Following the commissioning and/or validation, a full report detailing the findings should be produced, and the ventilation system will only be acceptable to a client such as GGC 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[34]."

3.22 The report should 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 (where required)

[30] Andrew Poplett, Hearing on 10 May 2022, at p.113 and p.114.
[31] Stephen Maddocks, Hearing on 12 May 2022, at p. 38.
[32] PMI 231, 8 July 2013.
[33] Draft for Consultation SHTM 03-01 Part A at paragraphs 8.67 to 8.174.
[34] HTM-03 Part A (2007), at page 73, para 8.64.

- estates and facilities[35]

Annual Verification

3.23 Critical ventilation systems require annual verification and quarterly maintenance checks. General ventilation systems do not require annual verification, but they do require annual maintenance[36].

3.24 Annual verification for critical ventilation systems is intended to establish that the ventilation system is still required, and that the AHU conforms to the minimum standard[37]. Amongst other things the annual verification is intended to establish that the general condition of the ventilation system is adequate in relation to ACH, pressure differentials and air-flow rates[38].

3.25 Ventilation system records and logbooks should be kept of commissioning information, operational management routine, monitoring and maintenance. The Health and Safety Executive ("HSE") and other interested bodies have a statutory right to inspect them at any time. All records should be kept for at least five years[39].

2015 Handover

3.26 On 29 January 2015, stage 3 (QEUH and RHC) sectional completion was certified to be 26 January 2015, 4 weeks earlier than the scheduled Completion Date of 28 February 2015[40].

3.27 Although the Employer's Requirements stated that the QEUH and RHC would have natural and mechanical ventilation[41], the Inquiry team understands that

[35] HTM-03 Part A (2007), at page 73, para 8.65.
[36] Draft for Consultation SHTM 03-01 Part B – Operational management and performance verification
[37] Draft for Consultation SHTM 03-01 Part B – Operational management and performance verification at paras 3.3 to 3.63, p.18 to p.24.
[38] Draft for Consultation SHTM 03-01 Part B – Operational management and performance verification at para 4.9, p.26.
[39] Draft for Consultation SHTM 03-01 Part B – Operational management and performance verification at paragraph 1.26, p.13.
[40] NHSGGC Sectional Completion Certificate dated 26 January 2015.
[41] Employer's Requirements, Section 5.0 (General Design and Construction Requirements) [Control of Infection] paragraph 5.6.1(b), Section 7.0 (Architectural Requirements) [Building Envelope]at paragraphs

parties must have agreed at some stage to have a fully mechanical ventilation system. The NSHG Ventilation Strategy (December 2009)[42] document notes that natural ventilation would not achieve GGC's temperature control requirement and sole use of mechanical ventilation was explored. The requirement for partly natural ventilation appears to have been impliedly derogated from in the M&E Clarification Log (2010 ItP) – Final as it stated that Chilled Beam Units ("CBUs") were the solution to control the environment which was not reliant on variable natural ventilation[43]. At handover in 2015, the QEUH and RHC were largely sealed with limited openable windows in order to control the internal environment within the spaces and limit the impact of odours from the adjacent Scottish Water works[44].

4. Purpose of Ventilation

4.1 In order to enable this PPP to be understood by a lay reader this section seeks to summarise the purpose of ventilation systems in a hospital by reference to evidence led in the Edinburgh hearing of the Inquiry that commenced on 9 May 2022 and the submissions of Counsel to the Inquiry in respect of that evidence.

4.2 Ventilation is the provision of air to dilute contamination generated within a space in order to provide a safe, suitable and comfortable environment to undertake an activity within a space[45].

4.3 Ventilation has three functions in a hospital:

- removal of odour and noxious smells;
- maintenance of comfortable temperature for patients and staff; and
- assisting in the prevention and control of infection[46].

4.4 Ventilation can be provided naturally by the effects of wind pressure (for example,

7.7.2(a) and (b), Section 8.0 (Building Services Requirements) [Ventilation and Air Conditioning] at paragraph 8.2.11.7.
[42] NHSG Ventilation Strategy (December 2009).
[43] M & E Clarification Log (2010 ItP) – Final.
[44] QEUH and RCH Building User Guide (FM) dated 23 January 2015 at p.24.
[45] Oral Evidence of Andrew Poplett, Hearing on 10 May 2022, at p.16.
[46] Bundle 6, Hearing 9 May 2022, Expert Report of Professor Hillary Humphreys, at p.10 (p.12 of Bundle).

opening a window). This would impact on maintaining consistent flow rates resulting in the inability to ensure minimum ventilation rates will be achieved. However, this variability is acceptable within some environments such as an office accommodation or a general hospital ward. Specialist areas will require mechanical ventilation to ensure that the ventilation system performs consistently irrespective of weather conditions[47].

4.5 A correctly designed, installed, and operated ventilation system can really help reduce the risk of infection. An incorrect ventilation system can increase the risk of infection and transmission[48].

4.6 Ventilation is just one control measure among many to reduce the risk of infection in a hospital. Other measures included prophylaxis antibiotics (these are antibiotics used to prevent as opposed to treat infections) and appropriate hand hygiene[49].

4.7 Mere dilution of contaminants will not be appropriate for immunocompromised patients who will require more stringent measures relating to filtration and directional airflow to reduce their risk of becoming acquiring an infection. The use of ventilation is significant for immunocompromised patients or those patients with virtually no immune system because of illness, transplant, or treatment. It can reduce exposure to potential airborne pathogens from surrounding areas or outside[50].

4.8 In a healthcare setting the two main categories of airborne risk are human derived airborne micro-organisms such respiratory viruses and tuberculosis and secondly environmentally derived agents such as fungi and environmental bacteria. Each have their own unique properties but can be considered harmful to patients, particularly vulnerable patients who are neutropenic (reduced number of neutrophil white blood cells). The ventilation must protect the patient from the immediate hospital environment but also from outside air (dust from nearby

[47] CSCIE, at paragraph 36.
[48] Bundle 6, Hearing on 9 May 2022, Expert report of Dr Shaun Fitzgerald, at p.7 (p.36 of Bundle).
[49] Bundle 6, Hearing on 9 May 2022, Expert report of Dr Hilary Humphreys at p. 12 (p.14 of Bundle).
[50] Statement of Andrew Poplett, paragraph 12, at p. 7.

construction work, winds carrying spores such as aspergillus fungus etc)[51].

5. Parameters in a Ventilation System

5.1 In the construction of a hospital building, a critical element is specification of the parameters to be achieved by the building's ventilation system. To design a ventilation system, an engineer will need to know what parameters the system is to achieve[52].

5.2 In the absence of a completed room data sheet, an engineer will have to interpret the relevant technical guidance and may have to make assumptions to determine the parameters to be achieved[53].

NHS Guidance

5.3 The Contract makes specific reference to a range of NHS Guidance which reflected distilled knowledge, consensus and best practice[54] built up over time by those involved in healthcare engineering.

5.4 The Employer's Requirements state that Multiplex shall:

- comply with the documents listed as "NHS Mandatory Documentation";
- have regard to the documents listed as "NHS Guidance Documentation", and
- comply with the standards, legislation and other documents listed in section 5.1.4 (Additional Guidance)[55] such as "current British Standards, European Standards and Codes of Practice, as appropriate".

5.5 The NHS Guidance relevant to this PPP is listed in Appendix 1.

5.6 For context, the earlier SHTM 2025 guidance originally provided guidance in

[51] Statement of Andrew Poplett, paragraph 12, at p. 7.
[52] CSCIE, at paragraph 71.
[53] CSCIE, at paragraph 71.
[54] CSCIE, at paragraph 194
[55] Employer's Requirements, Section 5.0 (General Design and Construction Requirements), at paragraphs 5.1.1.2.

relation to hospital ventilation systems. It stated that specific requirements for individual spaces and departments were included in the ADB A-Sheets[56].

5.7 In the period between the SHTM 2025 issued in June 2001 and the SHTM 03-01 Part A in 2013, there was a draft SHTM 03-01 Part A prepared in March 2009 for consultation (ultimately becoming the 2013 SHTM 03-01 Part A version). The 2013 SHTM 03-01 Part A is described in SHTM 00[57] at page 14 as:

> "…best practice guidance on design and air installation of ventilation systems and the close-control (mechanical cooling or air-conditioning) of general and 'specialised' healthcare environments."

5.8 Part A of the Draft for Consultation SHTM 03-01 concerns the design parameters for new installations. While Part B deals with operational management of systems. Paragraph 2.60 of Part A of the Draft for Consultation SHTM 03-01 states that:

> "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 (SHPNs)."

Key Ventilation Concepts

5.9 This part of this section of the PPP seeks to explain key ventilation concepts to enable the details set out in both in the narrative text in sections 6 of this PPP and Appendix 2 to be understood by a reader.

HEPA Filtration

5.10 A filter consists of a labyrinth of fibrous material contained in a frame. Its purpose is to capture and hold particles being carried in the airstream. The size, range and number of particles that exist in the air make it impossible for a filter to remove them all.

5.11 A HEPA filter is a High-Efficiency Particulate Air filter. HEPA filters will capture

[56] SHTM 2025 (Pt 2): Ventilation in healthcare premises (June 2001)
[57] SHTM 00 Best practice guidance for healthcare engineering, policies and principles (Feb 2013)

particles. HEPA filters do not filter out gases or odours[58]. There are different grades of filters with the lowest being G2 to G4. In the middle there is EPM 1 (formerly F7). At the top end[59] there is the HEPA filter (H12)[60].

5.12 Immunocompromised or neutropenic areas of a hospital require HEPA filtration[61].

Room Air Change Rate ("ACH")

5.13 In relation to a specific hospital room, the supply of air to a room has four functions:

1. to dilute airborne contamination;
2. to control air movement within such that the transfer of airborne contaminants from less clean to cleaner areas is minimised;
3. to control the temperature and if necessary, the humidity of the space[62]; and
4. to assist in the removal of and dilute waste gases where used[63].

5.14 The general principle for shared rooms is that infection risk increases as the air change rate per hour reduces. 2 ACH is a vital threshold for human health which relates to the build-up of CO2[64]. The position in relation to single rooms is unknown[65] but would ultimately depend on airflows between single rooms, corridors and the number of visitors.

5.15 The number of ACH is not an exact science. Ultimately, it is a compromise agreed between contributors (including engineers and IPC professionals). The number of ACH agreed in the NHS Guidance is based on research conducted by Owen Lidwell and his research group in the 1970s. It is simply an agreed consensus that the stated level of ACH within the NHS Guidance provide a safe environment for

[58] Oral evidence of Andrew Poplett, Hearing on 10 May 2022, at p.57.
[59] It should be noted the highest HEPA filter is H14.
[60] Oral evidence of Andrew Poplett, Hearing on 10 May 2022, at p.56 and p.57.
[61] Oral evidence of Andrew Poplett, Hearing on 10 May 2022, at p. 60
[62] Bundle 6, Expert Report of Stephen Maddocks, at p.20 (Bundle p.72)
[63] Bundle 6, Expert Report of Stephen Maddocks, at p.21 (Bundle p.73)
[64] Queen Elizabeth University Hospital Review Report, June 2020, at paragraph 4.5.25
[65] Queen Elizabeth University Hospital Review Report, June 2020, at paragraph 4.5.25

patients; it does not necessarily follow that failure to comply with the stated level of ACH will always be a risk to patients. That said, non-compliance may create a risk to patients[66].

5.16 ACH is the volume of air present within a room and the number of times that the whole room volume changes. Approximately every air change within a room will remove 63% of airborne contamination so by six air changes 99.8% of any residual airborne contamination will have been removed[67]. Air change rates are calculated by finding out the volume flow rate of air into the room through a given duct against the size of the room that the air is flowing into[68].

Room Air Pressure

5.17 Positive pressure ventilation is used for protecting very vulnerable patients and is known as protective isolation. This is required to protect neutropenic patients such as those undergoing chemotherapy or organ transplantation from exposure to airborne environmental pathogens. The air in these patients' rooms should be higher pressure (for example 5 or 10 Pa) so that it moves to surrounding clinical areas. This prevents the ingress of air with potential airborne pathogens from the rest of the ward[69].

5.18 In some circumstances negative ventilation pressure may be used to prevent infection. This type of pressure ventilation is used where the patient has a transmissible airborne infection (source isolation) and there is a risk of aerosol transmission from the patient spreading to other patients in the ward. In other words, that air does not spread from the isolation room to the surrounding ward as the air pressure is negative there compared to other clinical areas nearby. A patient with a serious lung infection such as tuberculosis would fall into this category of a patient requiring negative pressure[70].

[66] CSCIE, at paragraph 58.
[67] Oral evidence of Andrew Poplett, Hearing on 10 May 2022, at p.28 and p.29.
[68] Oral evidence of Andrew Poplett, Hearing on 10 May 2022, at p .30.
[69] Bundle 6, Hearing 9 May 2022, Expert Report of Professor Hillary Humphreys, at p.11 (p.13 of Bundle).
[70] Bundle 6, Hearing 9 May 2022, Expert Report of Professor Hillary Humphreys, at p.11 (p.13 of Bundle).

Chilled Beam Units ("CBUs")

5.19 A CBU is a radiator-type arrangement that is normally mounted on the ceiling, where warm air rises within a space through convection. The warm air meets the chilled beam which cools down the air and that air moves towards the floor of the room by convection. The air moves in a cycle by convection passively[71].

5.20 An active CBU is exactly the same as a passive CBU but can include a degree of fresh air supply provided by a duct to the CBU[72].

5.21 CBUs are efficient and useful in certain environments such as office buildings with sealed windows and no fresh air[73].

5.22 The use of CBUs in clinical areas of hospitals (bedroom spaces, ward area, patient overnight spaces and treatment spaces) is not recommended by the current edition of HTM 03-01 (although it should be noted that earlier HTM editions, namely the 2007 edition, applicable at the time of the contract did not have this recommendation) because (i) moisture will condense on surfaces and promote the proliferation of micro-organisms; and (ii) they need regular maintenance to keep them operating in a satisfactory condition[74].

Sealed Bedroom/Ensuites

5.23 A sealed ceiling is a ceiling system that is designed to be airtight which should be smooth, jointless and impervious. A suspended ceiling is a group of individual tiles set in a grid.

Airlock Entrance to Ward

5.24 An airlock door barrier is a system designed to control the flow of air between two adjoining spaces, particularly in environments where maintaining specific air quality or pressure is critical. The primary purpose of an airlock is to prevent the uncontrolled exchange of air and contaminants between two areas. The key

[71] Oral evidence of Andrew Poplett, Hearing on 10 May 2022, at p.53
[72] Oral evidence of Andrew Poplett, Hearing on 10 May 2022, at p.53.
[73] Oral evidence of Andrew Poplett, Hearing on 10 May 2022, at p.63.
[74] Oral evidence of Andrew Poplett, Hearing on 10 May 2022, at p54 and p.55.

features of an airlock are two doors in close proximity with one leading into the airlock and the other leading out. The doors do not open simultaneously to minimise a direct path for air to flow between two spaces.

Backup Air Handling Unit ("AHU")

5.25 An Air Handling Unit ("AHU") is a piece of machinery which circulates and regulates air as part of a ventilation system. The primary purpose of a backup air handling unit is to take over the functions of the primary air handling unit in case of failure or scheduled maintenance. Air handling units are used to treat and distribute air throughout the various areas of a hospital. They play a crucial role in maintaining air quality, controlling infection risk, and creating a comfortable and safe environment for patients, hospital staff and visitors.

Pressure Monitoring System

5.26 A pressure monitoring system is a set of tools and devices that are required to monitor specific pressures within a healthcare setting. The purpose of the pressure monitoring system is to inform the relevant people immediately if the ventilation system is operating out of specification, for example, by being alarmed to a nursing station.

6. Ventilation Systems in Wards

6.1 The prevention and control of infection was to be a primary consideration of Multiplex in the design and construction of the QEUH/RHC. Multiplex was required to demonstrate to GGC's ICT that the design and construction of the hospital fully reflected and incorporated the ventilation system, being a key infection control challenge[75].

6.2 This section of the PPP summarises the information contained in the tables in Appendix 2 to the PPP. The tables in that appendix are the principal record of the information contained in this PPP and the following sections are summaries of

[75] Employer's Requirements, at clause 5.6.1 [Control of Infection]

what is contained in the appendix.

QEUH General Wards

6.3 This section summarises the principal features of the ventilation system in the General Wards of the QEUH. The majority of wards in the hospital are general wards. However, it is noted that while Infectious Diseases on Level 5 and Respiratory and Cystic Fibrosis on Level 7 were designed as general wards, they may be considered as specialist wards . All these wards have general ventilation systems installed.

HEPA Filtration

6.4 The NHS Guidance included Draft for Consultation SHTM 03-01 Part A (2009). A G4 filter was deemed suitable for general areas[76].

6.5 The HTM 03-01 Part A (2007) guidance was also specifically listed in the NHS Guidance. In Appendix 2 of HTM 03-01 Part A (2007), a general ward's filter requirement is non-HEPA, SUP2.

6.6 At handover in January 2015, no HEPA filtration was required, and no HEPA filtration was installed at handover. This is therefore **not** a potentially deficient feature for the purposes of Glasgow III.

Room Air Change Rate ("ACH")

6.7 In both Appendix 2 of HTM 03-01 Part A (2007) and Appendix 1 of Draft for Consultation SHTM 03-01 Part A (2009), the number of air changes for general wards is stated to be 6 ACH. Accordingly, NHS Guidance required 6 ACH in the General Wards of the QEUH.

6.8 The M&E Clarification Log (2010 ItP) – Final notes that "Ward Air change to be 6AC/HR, currently shown as 2.5 AC/HR which is not in compliance with SHTM 03-01". Mulitplex's response is recorded as "'… All accommodation is single

[76] Table A1, Draft for Consultation SHTM 03-01 Part A at page 140.

bedrooms and therefore the need for dilution of airborne microbiological contamination should be reduced…Providing 6 air changes is energy intensive and not necessary." The agreed position is noted as "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…." GGC confirmed agreement to this proposed derogation.[77] This was built.

6.9 At handover in 2015 single bedrooms, in general wards had approximately 2.5 ACH which was below NHS Guidance, and this remains the case[78]. This is a potentially deficient feature for the purposes of Glasgow III.

Room Air Pressure

6.10 In both Appendix 2 of HTM 03-01 Part A (2007) and Appendix 1 of the Draft for Consultation SHTM 03-01 Part A (2009), the room air pressure is stated to be "0 or -ve" for a single room. Accordingly, NHS Guidance required that for General Wards room air pressure of 0 or -ve was required in the single rooms within the General Wards of the QEUH.

6.11 At handover in 2015 the room pressure was "0 or slightly -ve relative to the corridor" and this is **not** a potentially deficient feature for the purposes of Glasgow III.

Chilled Beams ("CBUs")

6.12 The Employer's Requirements stated that "the use of active chilled beams should be considered within all ward areas"[79]. The NHS Guidance[80] required that if using CBUs, they be positioned carefully to avoid cold draughts. Control settings ensure that beams' external elements are always above dewpoint and should be easily accessible for maintenance.

6.13 CBUs were installed in the wards at handover. Some core participants and others

[77] M & E Clarification Log Final (2010 ItP) – Final.
[78] M & E Clarification Log Final (2010 ItP) – Final.

[79] Employer's Requirements, Section 2.4 (Main Hospital Building), at paragraphs 2.4.3 [Chilled Beams].
[80] Draft for Consultation SHTM 03-01 Part A at p.30 and HTM 03-01 Part A (2007) at p.11

have challenged the use of CBUs in the QEUH. Furthermore, the use of CBUs in clinical areas, is not recommended by the current edition of SHTM 03-01 (2022). This is a potentially deficient feature for the purposes of Glasgow III.

Commissioning & Validation

6.14 At handover in 2015, commissioning of the ventilation system in the General Wards had been carried out but there was no validation of the ventilation system. This is a potentially deficient feature for the purposes of Glasgow III.

Annual Verification

6.15 The Inquiry team understands that no annual verification of the ventilation system was carried out post-handover until circa 2018 or 2019.

RHC Ward 2A - Haematology and Oncology and Teenage Cancer Trust ("TCT")

6.16 Ward 2A Haemato-oncology (Schiehallion Unit) was located in the RHC.

6.17 Haemato-oncology wards are for patients with a range of malignant and non-malignant haematology conditions. A significant number of the patients receive chemotherapy, which renders them immunocompromised or neutropenic and that leaves them potentially vulnerable to infection.

6.18 The ward provides services in the following areas:

- General in-patient ward (high dependency);
- National Bone Marrow Transplant (BMT) Unit; and
- Teenage Cancer Trust (TCT) ward.

6.19 This PPP considers the in-patient ward and TCT ward. The BMT isolation rooms will be covered in a separate PPP.

6.20 The patients accommodated in the Schiehallion ward (in-patient and TCT ward) were immunocompromised and considered high-risk. This ward required specialist

ventilation; however, it was designed and built as a general ward.

6.21 On 26 September 2018, the patients in Ward 2A were transferred to Ward 6A in the QEUH while upgrade works were carried out in 2019. On 9 March 2022, the patients returned to Ward 2A.

HEPA Filtration

6.22 In Appendix 2 of HTM 03-01 Part A (2007), there are two tables (tables 2 and 3) which summarise the design conditions for specific wards and rooms. A specific ward listed is a neutropenic patient ward and the supply filter grade in table 2 required is “H12” while in table 3 a haematology/oncology ward is “BS EN 1822 - EPA12”. These filter grade levels are classified as HEPA filters. The same outcome arises from the Draft for Consultation SHTM 03-01 Part A (2009).

6.23 The RHC COS makes no express requirement for HEPA filtration[81].

6.24 The Inquiry team considers that as a neutropenic patient ward, Ward 2A required H12 HEPA filtration according to NHS Guidance.

6.25 At handover in 2015, HEPA filtration should have been installed, particularly as the ward was accommodating neutropenic patients, but no HEPA filtration was in fact installed within Ward 2A. This is a potentially deficient feature for the purposes of Glasgow III.

Room Air Change Rate (“ACH”)

6.26 In Appendix 2 of HTM 03-01 Part A (2007), the number of air changes for a neutropenic patient ward is stated to be 10 ACH. The same outcome arises from the Draft for Consultation SHTM 03-01 Part A (2009). 10 ACH was required in ward 2A.

6.27 The M&E Clarification Log (2010 ItP) – Final includes Multiplex’s proposal of 40 litres of air per second per single room, on the assumption a patient and four others occupy a room (this is equivalent to 8 litres per person per second)

[81] COS for NSGACL Haemat-Oncology NCH_iss1_rev

(approx. 2.5 ACH for single bedrooms) which is less than NHS Guidance required[82]. GGC confirmed agreement to this derogation[83].

6.28 The Draft for Consultation SHTM 03-01 Part A (2009) standard of 10 ACH for critical/neutropenic areas, was derogated to 2.5 ACH. This is a potentially deficient feature for the purposes of Glasgow III.

Room Air Pressure

6.29 In Appendix 2 of HTM 03-01 Part A (2007) and Table A1 of the Draft for Consultation SHTM 03-01 Part A (2009) the room air pressure is stated to be "+10 Pa" for neutropenic patient ward.

6.30 The RHC COS refers to the ward benefiting from 'low positive pressure'[84].

6.31 NHS Guidance requires ward room air pressure of +10 Pa for Ward 2A as a ward with neutropenic patients.

6.32 The M&E Clarification Log (2010 ItP) – Final also derogated from room pressure differentials as noted on pages 3 and 4 of the Log where it is stated that "(rooms could also be at slightly negative pressure to corridor)". GGC agreed and noted negative pressure was to be created in the design solution[85]. This is a potentially deficient feature for the purposes of Glasgow III.

6.33 At handover, the room air pressure for this ward was found to be "0 or slightly negative -ve relative to the corridor", broadly in line with the derogation but significantly less than guidance. This is a potentially deficient feature for the purposes of Glasgow III.

Chilled Beams ("CBUs")

6.34 The Employer's Requirements stated that "the use of active chilled beams should

[82] Queen Elizabeth University Hospital Review Report, June 2020, at para 4.5.24
[83] M & E Clarification Log (2010 ItP) – Final
[84] COS for NSGACL Haemat-Oncology NCH_iss1_rev Section 7(1).
[85] M & E Clarification Log (2010 ItP) – Final at pages 3 and 4.

be considered within all ward areas[86]".

6.35 At handover, CBUs were installed in this ward. As some CPs and others have challenged the use of CBUs in the RHC and the use of CBUs in clinical areas is not recommended by the current edition of SHTM 03-01 (2022) this is a potentially deficient feature for the purposes of Glasgow III.

Sealed Bedroom/Ensuites

6.36 The RHC COS[87] did not require sealed bedrooms and ensuites. At handover in 2015, the ward's bedrooms and ensuites were not sealed and had suspended ceilings. However, given the air pressure requirements noted above this is a potentially deficient feature for the purposes of Glasgow III.

Air Lock Entrance to Ward

6.37 The RHC COS required that "The ward should be accessed by entry through a double-door barrier system.[88]"

6.38 At handover, it is understood that there was no airlock in place. One was subsequently fitted in the 2019 upgrade works. This is a potentially deficient feature for the purposes of Glasgow III.

Back Up AHU

6.39 The Employer's Requirements did not require a backup AHU for the ward and one was not installed at handover in 2015. Given the subsequent fitting of a back up AHU in the 2019 upgrade works the absence of one at handover is a potentially deficient feature for the purposes of Glasgow III.

Pressure Monitoring System

6.40 The RHC COS did not require a pressure monitoring system for the ward and one was not installed at handover in 2015. Given the subsequent fitting of a pressure

[86] Employer's Requirements, Section 2.4 (Main Hospital Building), at paragraphs 2.4.3 [Chilled Beams].
[87] COS for NSGACL Haemat-Oncology NCH_iss1_rev, Section 7(1).
[88] COS for NSGACL Haemat-Oncology NCH_iss1_rev, Section 7(1).

monitoring system in the 2019 upgrade works the absence of one at handover is a potentially deficient feature for the purposes of Glasgow III.

Commissioning and Validation

6.41 At handover in 2015, commissioning of the ventilation system in Ward 2A had been carried out but there was no validation of the ventilation system. This is a potentially deficient feature for the purposes of Glasgow III.

6.42 However, following the upgrade works in 2019, those works on the ventilation system were both commissioned and validated.

Annual Verification

6.43 No annual verification of the ventilation system was undertaken post-handover. This is a potentially deficient feature for the purposes of Glasgow III.

Ward 2A Upgrade Works

6.44 In 2019 upgrade works were carried out on Ward 2A which resulted in HEPA filtration being installed. The works increased the ACH from 2.5 ACH to 10 ACH bringing it in line with the Draft for Consultation SHTM 03-01 Part A (2009). The room pressure which was at the same level as a general ward was increased to +10 Pa.

6.45 The 2019 upgrade works also put right other issues by removing the CBUs and sealing the ceilings of the bedrooms and ensuites that had suspended ceilings. The works also installed an airlock at the entrance to the ward, and as illustrated in Table 2, installed a backup AHU and a pressure monitoring system.

6.46 The 2019 upgrade works brought Ward 2A in line with SHMT 03-01 Part A (2022) and no further works are necessary at the present time.

RHC Ward 2B - Paediatric Haematology and Oncology – Day Care Unit

6.47 Ward 2B is the Schiehallion Day Care Unit. It is understood by the Inquiry team

that because no patients stay overnight and only receive treatment on an outpatient basis during the day then it is does not fall within the category of a neutropenic ward. Accordingly, the Inquiry Team understands that the default position would be the standard of a general ward. Ultimately, the requirements would need to be defined by clinical IPC who could assess the patient groups and their risk requirements.

HEPA Filtration

6.48 In Appendix 2 of HTM 03-01 Part A (2007), there are two tables (tables 2 and 3) which summarise the design conditions for specific wards and rooms. A neutropenic patient ward would require H12 (HEPA) filtration but since this ward is not considered to be a neutropenic patient ward, then the supply filter grade in table 2 requiring “H12” (HEPA) is not applicable.

6.49 The RHC Haematology and Oncology COS makes no express requirement for HEPA filtration[89].

6.50 At handover in 2015, it is noted that no HEPA filtration was in fact installed within Ward 2B. However, HEPA filtration was later fitted to this ward in the 2019 upgrade works (see below). The absence of HEPA filtration in this ward at handover is **not** a potentially deficient feature for the purposes of Glasgow III.

Room Air Change Rate (“ACH”)

6.51 In Appendix 2 of HTM 03-01 (2007), the number of air changes for a general ward is stated to be 6 ACH.

6.52 The Inquiry team considers that for general wards the NHS Guidance required 6 ACH in Ward 2B.

6.53 The M&E Clarification Log (2010 ItP) – Final includes Multiplex’s proposal of 40 litres of air per second per single room, on the assumption a patient and four others occupy a room (this is equivalent to 8 litres per second per person) which is

[89] COS for NSGACL Haemat-Oncology NCH_iss1_rev

less than NHS Guidance required[90]. GGC confirmed agreement to this derogation[91].

6.54 At handover in 2015, ACH should have been 6 but was approximately 2.5 ACH, being the agreed derogation between the parties. This is a potentially deficient feature for the purposes of Glasgow III.

Room Air Pressure

6.55 In Appendix 2 of HTM 03-01 Part A (2007) and Table A1 of the Draft for Consultation SHTM 03-01 Part A (2009) there is no room air pressure value given for a general patient ward.

6.56 The RHC Haematology and Oncology COS states that it is not necessary to maintain a low level of positive pressure[92].

6.57 The M&E Clarification Log (2010 ItP) – Final had a comment which included room pressure differentials as noted on pages 3 and 4 of the Log where it is stated that "(rooms could also be at slightly negative pressure to corridor)". GGC agreed and noted negative pressure was to be created in the design solution[93]. In the absence of any requirement in the RHC COS and NHS Guidance there was no derogation required for room pressure. The room air pressure in this ward is **not** a potentially deficient feature for the purposes of Glasgow III.

Chilled Beams ("CBUs")

6.58 The Employer's Requirements stated that "the use of active chilled beams should be considered within all ward areas[94]. These were found to be installed in the ward's Day Care Units and the consulting rooms at handover in 2015.

6.59 As some CPs and others have challenged the use of CBUs in the QEUH and the use of CBUs in clinical areas are not recommended by the current edition of

[90] Queen Elizabeth University Hospital Review Report, June 2020, at para 4.5.24
[91] M & E Clarification Log (2010 ItP) – Final at pages 3 and 4.
[92] COS for NSGACL Haemat-Oncology NCH_iss1_rev Section 3.
[93] M & E Clarification Log (2010 ItP) – Final at pages 3 and 4.
[94] Employer's Requirements, Section 2.4 (Main Hospital Building), at paragraphs 2.4.3 [Chilled Beams].

SHTM 03-01 (2022), this is a potentially deficient feature for the purposes of Glasgow III.

Sealed Bedrooms

6.60 The RHC Haematology and Oncology COS did not require sealed bedrooms but in any event, it is understood by the Inquiry team that there are no bedrooms in Ward 2B as it is a day care unit and so this requirement is irrelevant. The ward had suspended ceilings rather than sealed ceilings. This is **not** a potentially deficient feature for the purposes of Glasgow III.

Airlock Entrance to Ward

6.61 The RHC Haematology and Oncology COS did not require an airlock entrance to ward in Ward 2B of the RHC and there was no airlock in place at handover in 2015. This is **not** a potentially deficient feature for the purposes of Glasgow III.

Backup AHU

6.62 The Employer's Requirements did not require a backup AHU in Ward 2B of the RHC and was not installed at handover in 2015. This is **not** a potentially deficient feature for the purposes of Glasgow III.

Pressure Monitoring System

6.63 The RHC Haematology and Oncology COS did not require a pressure monitoring system in Ward 2B for bedrooms and it was not installed at handover in 2015. This is **not** a potentially deficient feature for the purposes of Glasgow III.

Commissioning and Validation

6.64 At handover in 2015, commissioning of the ventilation system in the general wards had been carried out but there was no validation of the ventilation system. This is a potentially deficient feature for the purposes of Glasgow III.

6.65 Commissioning and validation of the ventilation system was carried out following the upgrade works in 2019.

Annual Verification

6.66 No annual verification of the ventilation system was undertaken post-handover. This is a potentially deficient feature for the purposes of Glasgow III.

Ward 2B - 2019 Upgrade Works

6.67 In 2019 upgrade works were carried out on Ward 2B, which resulted in HEPA filtration being installed. No works were carried out to increase the ACH which remained at the agreed derogated ACH of approximately 2.5 ACH. The room pressure which was at the same level as a general ward was not increased to positive pressure as no works were undertaken on this issue.

6.68 The 2019 upgrade works did not remove the CBUs. As some CPs and others have challenged the use of CBUs in the QEUH and the use of CBUs not recommended by the current edition of SHTM 03-01 (2022), this is a potentially deficient feature for the purposes of Glasgow III.

6.69 No upgrade works were undertaken in respect of sealed bedrooms and pressure monitoring system.

Ward 2B – 2024 Specification

6.70 In 2024 Ward 2B (Day Care Unit) was not in accordance with the NHS Guidance due to the ACH of 2.5 being below the required 6 ACH set out in Table A1 of the Draft for Consultation SHTM 03-01 Part A (2009). This is a potentially deficient feature for the purposes of Glasgow III.

QEUH Ward 4B - Bone Marrow Transplant (“BMT”) Unit

6.71 Ward 4B is the adult BMT Unit. The patients accommodated in this ward are considered the most vulnerable to infection and the highest risk in a healthcare setting.

6.72 Following a change order in 2013, it was decided that the Beatson West of Scotland Cancer Centre BMT Unit would move to the QEUH to be on a site with full ITU and HDU support.

6.73 Level 4 in the QEUH was originally intended to provide accommodation for Renal and Haemato-oncology. Ward 4B was to house haemato-oncology but it was agreed that this service would move to Ward 4C and the adult BMT Unit would be provided in Ward 4B.

6.74 No COS for the BMT Unit was provided. It appears that the Adult Haematology and Oncology COS was used for the BMT services and the design and construction.

6.75 Ward 4B was never designed to accommodate BMT patients. Paediatric patients were accommodated in this ward from November 2018 in order to enable works to be completed in the Schiehallion Unit.

6.76 The COS for the Adult Haemato-oncology states that:

> "high proportion of the patients receive chemotherapy and are immunocompromised, making them vulnerable to infection[95]."

6.77 The requirements in relation to ventilation were set out in the COS:

- no opening windows;
- no chilled beams;
- space sealed and ventilated;
- positive pressure to rest of hospital;
- all highly filtered air >90%, probably best HEPA; and
- adequate number of positive pressure sealed HEPA filtered side rooms for neutropenic patients as in the Beatson West of Scotland Cancer Centre.[96]

6.78 In July 2013, a Change Order was issued by GGC which confirmed that the BMT service would transfer to Ward 4B in the QEUH and the haematology patients that

[95] COS for NSGACL Haemato Oncology NSG_iss1_rev Section 1.
[96] COS for NSGACL Haemato Oncology NSG_iss1_rev, Section 1.

were originally planned to accommodate Ward 4B would move to Ward 4C.

6.79 The BMT Unit transferred from the Beatson West of Scotland Cancer Centre to the QEUH, Ward 4B on 6 June 2015. On 8 July 2015, the patients from Ward 4B returned to the Beatson Oncology Unit at Gartnavel Hospital. On 30 June 2018, following upgrade works, the patients returned to Ward 4B in the QEUH.

HEPA Filtration

6.80 The 2013 change order stated that the ward area required HEPA filtration to same standard as the current haemato-oncology ward[97]. The COS for haemato-oncology stated that patient bedrooms defined as 'side rooms for neutropenic patients' should have HEPA filtration. In any event, HTM 03-01 Part A (2007) guidance requires H12 (HEPA filtration) for neutropenic wards such as 4B.

6.81 On 23 June 2010, GGC notified[98] Multiplex in relation to a change to the Works Information which relates to HEPA filtration to remove HEPA filters for 8 single room wards in Haemato-oncology ward and this was implemented on or after 16 September 2010[99].

6.82 In July 2013, GGC instructed Multiplex to stop fit out works on Level 4 relating to HEPA filtration and other design changes[100] resulting in the work being halted due to a requested design change to be developed using the contract's RDD process.

6.83 Subsequently, on 2 October 2013, GGC accepted Multiplex's design and adaptation proposals for Level 4 (Haemato-oncology) of the QEUH in Zones 512, 513, and 514[101].

6.84 HEPA filtration was installed in ceiling diffusers in patient bedrooms at handover in 2015. A diffuser is a terminal at the end of the ventilation ductwork system which diffuses air into the room or provides a return air path for extracted air.

[97] Change Number 2 on the Change Control Procedure Form for Ward 4B, dated 9 July 2013.
[98] PMI 21, 23 June 2010
[99] NEC Compensation Event CE5056 dated 16 September 2010.
[100] PMI 228, 2 July 2013.
[101] NEC Compensation Event CE10675 dated 2 October 2013. The location of zones 512, 513, and 514 is not known by the Inquiry team.

6.85 However, all other spaces in ward 4B including the corridor had no HEPA filtration. This is a potentially deficient feature for the purposes of Glasgow III.

Room Air Change Rate ("ACH")

6.86 The Adult Haematology and Oncology COS made no reference to air change rates[102].

6.87 In Appendix 2 of HTM 03-01 Part A (2007), the number of air changes for a neutropenic patient ward is stated to be 10 ACH. The same result is obtained from the Draft for Consultation SHTM 03-01 Part A (2009).

6.88 The Inquiry team considers that the effect of NHS Guidance was that 10 ACH was required in Ward 4B.

6.89 The M&E Clarification Log (2010 ItP) – Final recorded the ACH derogation referred to previously. However, the Inquiry team understands that Ward 4B was an agreed exception to this derogation, presumably because the COS for this ward expressly stated that no chilled beams should be used.

6.90 The Draft for Consultation SHTM 03-01 Part A (2009) required a standard of 10 ACH for critical/neutropenic areas. It was 6 ACH at handover in 2015. This is a potentially deficient feature for the purposes of Glasgow III.

Room Air Pressure

6.91 In Appendix 2 of HTM 03-01 (2007) Part A and Table A1 of the Draft for Consultation SHTM 03-01 the room air pressure is stated to be "+10 Pa" for neutropenic patient ward.

6.92 The Adult Haematology and Oncology COS refers to the ward having 'positive pressure to rest of hospital[103].

6.93 Accordingly, the Inquiry team considers that in relation to this ward, the effect of the NHS Guidance was that room air pressure of +10 Pa was required within the

[102] COS for NSGACL Haemato Oncology NSG_iss1_rev Section 1.
[103] COS for NSGACL Haemato Oncology NSG_iss1_rev Section 1.

patient bedrooms in Ward 4B. At handover, the room pressure differentials were found to be 3-4 Pa +ve relative to the ward corridor. This is a potentially deficient feature for the purposes of Glasgow III.

Chilled Beams ("CBUs")

6.94 The Adult Haematology and Oncology COS (which formed part of the Employer's Requirements) stipulated that there be no CBUs [104]. Accordingly, no CBUs were to be installed within Ward 4B of the QEUH and there were none at handover in 2015. This is **not** a potentially deficient feature for the purposes of Glasgow III.

Sealed Bedroom/Ensuites

6.95 The Adult Haematology and Oncology COS (which formed part of the Employer's Requirements) stipulated that "space sealed"[105] which it is understood by the Inquiry team to mean the bedrooms and ensuites were to be sealed.

6.96 This was not the case at handover in 2015 as the ward had suspended ceilings. This is a potentially deficient feature for the purposes of Glasgow III.

Airlock Entrance to Ward

6.97 The Adult Haematology and Oncology COS did not require an airlock entrance to Ward 4B of the QEUH and no airlock entrance was installed at handover in 2015. This is **not** a potentially deficient feature for the purposes of Glasgow III.

Backup AHU

6.98 The Employer's Requirements did not require a backup AHU in Ward 4B of the QEUH and one was not installed at handover in 2015. However, given the terms of the 2017 SBAR upgrade works, the absence of one at handover is a potentially deficient feature for the purposes of Glasgow III.

[104] COS for NSGACL Haemato Oncology NSG_iss1_rev, Section 1.
[105] COS for NSGACL Haemato Oncology NSG_iss1_rev, Section 1.

Pressure Monitoring System

6.99 The Adult Haematology and Oncology COS did not require a pressure monitoring system for the ward's bedrooms. However, given that a pressure monitoring system was also installed during the 2015 upgrade works, the absence of one at handover is a potentially deficient feature for the purposes of Glasgow III.

Commissioning and Validation

6.100 At handover in 2015, commissioning of the ventilation system in the general wards had been carried out but there was no validation of the ventilation system. This is a potentially deficient feature for the purposes of Glasgow III

6.101 As shown in in the table for Ward 4B in Appendix 2, commissioning and validation of the ventilation system was carried out following the upgrade works in July 2015 and September 2017.

Ward 4B July 2015 Upgrade Works

6.102 In July 2015, upgrade works were undertaken in Ward 4B which resulted in some changes to certain ventilation issues. The room pressure of 3-4 Pa was increased to approximately 5+ Pa. Bedrooms which had suspended ceilings of the patient bedrooms were sealed by the use of plasterboard although the ensuites remained with suspended ceiling tiles. A pressure monitoring system was also installed during the 2015 upgrade works. The ACH rates of below 10 ACH, room pressure readings below 10 Pa and lack of HEPA filtration to the corridor remained a potentially deficient features for the purpose of Glasgow III.

Ward 4B December 2015 Recommendations NSS SBAR

6.103 In December 2015 an SBAR[106] was issued by Health Protection Scotland ("HPS") which recommended the following:

[106] Support had been requested from HPS by GGC regarding an assessment of the ventilation requirements which would allow GGC to provide a safe environment for the care of BMT patients. HPS provided an SBAR that made several recommendations.

- HEPA filtered air into the rooms;
- Ideally the corridor should also be supplied with HEPA filtered air;
- 10 ACH;
- 10 Pa;
- sealed ceilings within the bedrooms and ensuites; and
- continuous pressure monitoring system.

6.104 The SBAR December 2015 Recommendations would have brought the ward into line with the Draft for Consultation SHTM 03-01 Part A (2009) requirements.

Ward 4B - September 2017 Upgrade Works

6.105 The 2017 upgrade works resulted in the ensuites becoming sealed by the use of plasterboard which the Inquiry team understands to be partial implementation of a PMI issued by GGC on 9 March 2016[107].

Ward 4B October 2017 Recommendations NSS SBAR

6.106 In October 2017 an SBAR was issued by HPS which recommended the following:

- HEPA filtered air into the rooms;
- ideally the corridor should also be supplied with HEPA filtered air;
- 10 ACH;
- 10 Pa;
- sealed ceilings within the bedrooms and ensuites;
- one air handling unit required to be addressed (e.g. planned shut downs or unplanned events (such as motor failures or power failures); and

[107] PMI 471 dated 9 March 2016.

- continuous pressure monitoring system.

6.107 The 2017 SBAR mirrored the 2015 SBAR with one change which was to address the one air handling unit. In other words, to install a backup AHU. It should also be noted that the SBAR stated that:

> "The validation of the entire system should be as detailed in the generic guidance given in SHTM 03-01 part A and verification of the entire system should be as outlined in SHTM 03-01 part B. These may have to be adapted to meet the requirements of this situation.[108]"

Ward 4B – 2024 Specification

6.108 In 2024 Ward 4B does not have HEPA filtered corridors and the room air change rate is not 10 ACH but is 6 ACH. These are potentially deficient features for the purpose of Glasgow III.

QEUH Ward 4C Haemato-oncology & Renal

6.109 Ward 4C is the adult Haemato-oncology and renal ward. The Haemato-oncology patients accommodated in Ward 4C are immunocompromised and require specialist ventilation.

6.110 Level 4 in the QEUH was originally intended to provide accommodation for Renal and Haemato-oncology. Haemato-oncology was to be in Ward 4B, however, the service was moved to Ward 4C following the transfer of the BMT Unit to Ward 4B.

6.111 Ward 4C was never designed to accommodate Haemato-oncology patients.

6.112 The Inquiry team considers that the Haemato-oncology COS applies to this ward because neutropenic patients were already allocated to this ward before handover[109]. This resulted in a section of the ward becoming in effect a neutropenic patient ward pre-handover bringing with it the more onerous

[108] NSS SBAR October 2017 Recommendations.
[109] COS for NSGACL Haemato Oncology NSG_iss1_rev; COS for NSGACL Renal NSG_iss1_rev; COS for NGACL Renal Dialysis NSG_iss1_rev.

ventilation requirements for a neutropenic patient ward set out in the Draft for Consultation SHTM 03-01 Part A (2009).

HEPA Filtration

6.113 In Appendix 2 of HTM 03-01(2007), there are two tables (tables 2 and 3) which summarise the design conditions for specific wards and rooms. A specific ward listed is a neutropenic patient ward and the supply filter grade in table 2 required is "H12" while in table 3 a haematology/oncology ward is "BS EN 1822 – EPA12". These filter grade levels are classified as HEPA filters. The same outcome arises from Table A1 of the Draft for Consultation SHTM 03-01 Part A (2009) where a neutropenic patient ward must have H12 (HEPA filter).

6.114 The Adult Haematology and Oncology COS expressly required highly filtered air >90% and HEPA filtered side rooms for neutropenic patients. In any event, HTM 03-01 Part A (2007) guidance would require H12 (HEPA filtration) for neutropenic wards such as 4C[110].

6.115 At handover in 2015, HEPA filtration should have been installed within Ward 4C but was not. This is a potentially deficient feature for the purposes of Glasgow III.

Room Air Change Rate ("ACH")

6.116 The Adult Haematology and Oncology COS makes no reference to air change rates[111].

6.117 In Appendix 2 of HTM 03-01 Part A (2007), the number of air changes for a neutropenic patient ward is stated to be 10 ACH. Accordingly, the Inquiry team considers that in this ward the effect of the NHS Guidance was that 10 ACH was required in Ward 4C.

6.118 The M&E Clarification Log (2010 ItP) – Final includes Multiplex's proposal of 40 litres of air per second per single room, on the assumption a patient and four others occupy a room (this is equivalent to 8 litres per second per person)

[110] COS for NSGACL Haemato Oncology NSG_iss1_rev, Section 1.
[111] COS for NSGACL Haemato Oncology NSG_iss1_rev, Section 1.

(approx. 2.5 ACH for single bedrooms) which is less than NHS Guidance required [112]. GGC confirmed agreement to this proposal[113].

6.119 The Draft for Consultation SHTM 03-01 Part A (2009) standard of 10 ACH for critical/neutropenic areas, was derogated to 2.5 ACH. This is a potentially deficient feature for the purposes of Glasgow III.

Room Air Pressure

6.120 In Appendix 2 of HTM 03-01 of Part A (2007) and Table A1 of the Draft for Consultation SHTM 03-01 Part A (2009) the room air pressure is stated to be "+10 Pa" for neutropenic patient ward.

6.121 The Adult Haematology and Oncology COS refers to the ward 'positive pressure to rest of hospital[114].

6.122 Accordingly, the Inquiry team considers that in relation to this ward the effect of the NHS Guidance was that room air pressure of +10 Pa within the patient bedrooms in Ward 4C.

6.123 The M&E Clarification Log (2010 ItP) – Final also derogated from room pressure differentials as noted on pages 3 and 4 of the Log where it is stated that "(rooms could also be at slightly negative pressure to corridor)". GGC agreed and noted negative pressure was to be created in the design solution[115]. This was a derogation of the +10 Pa for the Ward 4C. This is a potentially deficient feature for the purposes of Glasgow III.

Chilled Beams ("CBUs")

6.124 The Adult Haematology and Oncology COS prohibited CBUs for a ward dealing with a neutropenic patient group[116] but there was an agreed derogation in the Final M & E Clarification Log[117] to allow CBUs, and these were found to be

[112] Queen Elizabeth University Hospital Review Report, June 2020, at para 4.5.24
[113] M & E Clarification Log (2010 ItP) – Final at pages 3 and 4
[114] COS for NSGACL Haemato Oncology NSG_iss1_rev, Section 1., Section 1.
[115] M & E Clarification Log (2010 ItP) – Final at pages 3 and 4.
[116] COS for NSGACL Haemato Oncology NSG_iss1_rev, Section 1., Section 1.
[117] M & E Clarification Log (2010 ItP) – Final at page 3

installed in Ward 4C at handover in 2015.

6.125 As some CPs and others have challenged the use of CBUs in the QEUH and the use of CBUs not recommended by the current edition of SHTM 03-01 (2022). This is a potentially deficient feature for the purposes of Glasgow III.

Sealed Bedroom/Ensuites

6.126 The Adult Haematology and Oncology COS stipulated that the ward should have "space sealed"[118].

6.127 Accordingly, the Inquiry team considers that in this ward the effect of the Adult Haematology and Oncology COS was that sealed bedrooms and ensuites were required in Ward 4C, but this was not the case at handover in 2015 as the ward had suspended ceilings. This is a potentially deficient feature for the purposes of Glasgow III.

Airlock Entrance to Ward

6.128 The Adult Haematology and Oncology COS did not require an airlock entrance to Ward 4C of the QEUH and there was no airlock in place at handover in 2015. This is a potentially deficient feature for the purposes of Glasgow III.

Back Up AHU

6.129 The Employer's Requirements did not require a backup AHU in Ward 4C and one and was not installed at handover in 2015. This is **not** a potentially deficient feature for the purposes of Glasgow III.

Pressure Monitoring System

6.130 The Adult Haematology and Oncology COS (which formed part of the Employer's Requirements) did not require a pressure monitoring system in Ward 4C and was not installed at handover in 2015. However, this ward should have had +10Pa which would require pressure monitoring, this is a potentially deficient feature for

[118] COS for NSGACL Haemato Oncology NSG_iss1_rev, Section 1., Section 1.

the purposes of Glasgow III.

Ward 4C Commissioning and Validation

6.131 At handover in 2015, commissioning of the ventilation system in Ward 4C had been carried out but there was no validation of the ventilation system. This is a potentially deficient feature for the purposes of Glasgow III.

Ward 4C Annual Verification

6.132 The Inquiry team understands that no annual verification of the ventilation system was carried out post-handover until circa 2018 or 2019. This is a potentially deficient feature for the purposes of Glasgow III.

Ward 4C – 2024 Specification

6.133 In 2024 Ward 4C is not in accordance with the Draft for Consultation SHTM 03-01 Part A (2009) or the 2013 version of the SHTM 03-01 Part A. The only mitigating measures are freestanding mobile HEPA filter units in both the bedrooms and corridors and recirculation air scrubber fans (Camfil Camcleaner 400 concealed fan units) in the ensuites. Ward ACH rates remain at 2.5, room pressure is 0 or-ve, chilled beams are installed and suspended ceilings are present throughout. These are all potentially deficient features for the purposes of Glasgow III.

QEUH Ward 6A - Decanted location of the Schiehallion Unit

6.134 This ward was originally designated as an adult rheumatology ward and was designed as a general ward; it had no specialist ventilation requirements. On 26 September 2018 the original patient group was moved to accommodate haemato-oncology paediatric patients from Ward 2A in the RHC that moved into the ward during November 2018. The environmental conditions on Ward 6A in the QEUH were the same as those found in Ward 2A in the RHC.

6.135 After decant, the neutropenic patients from RHC were in a ward designed for general patients without the more onerous ventilation requirements in accordance with the Draft for Consultation SHTM 03-01 Part A (2009) guidance. The arrival of the neutropenic patients post-handover in the ward turned the general ward into a

neutropenic ward with the more onerous ventilation requirements. Non-extensive upgrade works were undertaken throughout 2019. On 9 March 2022, the paediatric patients returned to Ward 2A in the RHC. The decant to Ward 6A is a potentially deficient feature for the purposes of Glasgow III.

HEPA Filtration

6.136 In Appendix 2 of HTM 03-01 Part A (2007), a general ward's filter requirement is non-HEPA, SUP2.

6.137 Accordingly, NHS Guidance did not require HEPA filtration in the Ward 6A of the QEUH and no HEPA filtration was installed at handover. At the time of handover this was **not** a potentially deficient feature.

Room Air Change Rate ("ACH")

6.138 In both Appendix 2 of HTM 03-01 Part A (2007) and Appendix 1 of Draft for Consultation SHTM 03-01 Part A (2009) the number of air changes for general wards is stated to be 6 ACH. Accordingly, the Inquiry team considers that for general wards the effect of the NHS Guidance was that 6 ACH was required in the General Wards of the QEUH.

6.139 The M&E Clarification Log (2010 ItP) – Final includes Multiplex's proposal of 40 litres of air per second per single room, on the assumption a patient and four others occupy a room (this is equivalent to 8 litres per second per person) (approx. 2.5 ACH for single bedrooms) which is less than NHS Guidance required[119]. GGC confirmed agreement to this proposal[120].

6.140 As discussed above the Draft for Consultation SHTM 03-01 Part A (2009) standard of 6 ACH for general wards was derogated to 2.5 ACH. This is a potentially deficient feature for the purposes of Glasgow III.

[119] Queen Elizabeth University Hospital Review Report, June 2020, at para 4.5.24
[120] M & E Clarification Log (2010 ItP) – Final

Room Air Pressure

6.141 In Appendix 2 of HTM 03-01 Part A (2007) and Table A1 of Draft for Consultation SHTM 03-01 Part A (2009), the room air pressure is stated to be "0 or -ve" for a single room.

At handover in 2015 the room pressure was "0 or slightly -ve relative to the corridor". This is a potentially deficient feature for the purposes of Glasgow III.

Chilled Beams ("CBUs")

6.142 The Employer's Requirements stated that "the use of active chilled beams should be considered within all ward areas[121]".. The NHS Guidance[122] required that if using CBUs they be positioned carefully to avoid cold draughts, control settings ensure that external elements of beam are always above dewpoint and should be easily accessible for maintenance. At handover, there were CBUs installed in the wards.

6.143 As some CPs and others have challenged the use of CBUs in the QEUH and the use of CBUs not recommended by the current edition of HTM 03-01. This is a potentially deficient feature for the purposes of Glasgow III.

Ward 6A Commissioning and Validation

6.144 At handover in 2015, commissioning of the ventilation system in Ward 6A had been carried out but there was no validation of the ventilation system. This is a potentially deficient feature for the purposes of Glasgow III.

Ward 6A Annual Verification

6.145 The Inquiry team understands that no annual verification of the ventilation system was carried out post-handover until circa 2018 or 2019. This is a potentially deficient feature for the purposes of Glasgow III.

[121] Employer's Requirements, Section 2.4 (Main Hospital Building), at paragraphs 2.4.3 [Chilled Beams].
[122] Draft for Consultation SHTM 03-01 Part A at p.26 and HTM 03-01 Part A (2007) at p.11.

Ward 6A – 2019 Upgrade Works

6.146 The transfer of patients from Ward 2A on 26 September 2018 effectively changed Ward 6A from a general ward to a ward for neutropenic patients with the more onerous requirements that brings with it such as HEPA filtration, 10 ACH, and 10+ Pa [123].

6.147 Throughout 2019, upgrade works were undertaken to Ward 6A which resulted in some changes to certain ventilation issues. Mitigation measures were introduced concerning HEPA filtration with 3 portable HEPA filter units being placed in rooms 20, 21, and 23. In August 2019, air scrubber fans (Camfil Camcleaner 400 concealed fan units) were installed in the ceiling space of patient en-suite rooms within the ward. Notwithstanding these changes the ventilation of Ward 6A whilst it was used as a decant for the Schiehallion Unit remains a potentially deficient feature for the purposes of Glasgow III.

6.148 On 2 September 2019, flexible push fit connectors were changed relating to the CBUs.

APPENDIX 1: NHS GUIDANCE RELEVANT FOR THIS PPP12

- HTM 03-01 Part A: Specialised ventilation for healthcare premises Part A (2007)
- HTM 03-01 Part B: Specialised ventilation for healthcare premises Part B (2007)
- Draft for Consultation SHTM 03-01 Part A: Specialised ventilation for healthcare premises (2009)
- Draft for Consultation SHTM 03-01 Part B: Specialised ventilation for healthcare premises (2010)
- SHTM 03-01 Ventilation for healthcare premises Part A – Design and validation (2013)
- SHTM 03-01 Part A The concept, design, specification, installation and

[123] Draft for Consultation SHTM 03-01 Part A.

acceptance testing of healthcare ventilation systems (2022)

APPENDIX 2: PPP12 VENTILATION TABLE

See PPP12 Ventilation Table in Excel format which is produced separately.

APPENDIX 3: M&E CLARIFICATION LOG (2010 ItP) – FINAL EXCERPT

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									
	-	-	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 corridor). Providing 6 air changes is energy intensive and not necessary.		**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 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.	Energy model based on the agreed 2009 position.	Agreed

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SCOTTISH
HOSPITALS
INQUIRY

SCOTTISH HOSPITALS INQUIRY

Provisional Position Paper 13

Queen Elizabeth University Hospital and Royal Hospital for Children

Procurement History and Building Contract

Contents

1. PART 1: INTRODUCTION, PRFs and QUESTIONS

1.1 PPP Outline

This Provisional Position Paper ("PPP") consists of:

Part 1: Introduction, Potentially Relevant Features, and Questions for CPs
Part 2: The Building Contract
Part 3: Chronological Narrative

Appendix A: Terms of Reference (extract)
Appendix B: Key Organisations
Appendix C: Timeline - Key Dates

Note that there is likely to be some overlap between some of the issues identified in this PPP and matters to be addressed in a later Governance PPP to be produced by the Inquiry Team.

1.2 PPP Purpose

This PPP has been produced to assist the Chair in addressing the Remit and Terms of Reference by providing the factual matrix and identifying potentially relevant features relating to:

- the procurement by NHS Greater Glasgow and Clyde ("GGC") of the Queen Elizabeth University Hospital/Royal Hospital for Children ("QEUH/RHC"), Glasgow; and

- the contract between Brookfield Construction (UK) Limited ("Brookfield") and Greater Glasgow Health Board ("GGC") for the design and build of the QEUH/RHC dated 18 December 2009 (the "Building Contract").

The issues considered in this PPP are of particular relevance to Terms of Reference 2, 3C, 4 and 6. Understanding how the QEUH/RHC project was defined and then procured, how it was that the contract between GGC and its building contractor came to be in the form that it was agreed, what the terms of that contract were and how it came to be applied during the construction process, all provide the vital context and factual underpinning for many of the questions that arise from those Terms of Reference. The Terms of Reference referred to above have been reproduced in Appendix A for ease of reference.

Earlier this year, the Inquiry issued Provisional Position Paper 11 titled: "Potentially Deficient Features of the water system of the QEUH/RHC" ("PPP 11") and Provisional Position Paper 12 titled: "Potentially Deficient Features of the ventilation system of the Queen Elizabeth University Hospital And the Royal Hospital for Children" ("PPP 12"). Those PPPs set out features of the ventilation and water systems that did or do not conform to statutory regulations or other

recommendations, guidance, or good practice[1] ("Potentially Deficient Features"). Core Participants have commented on PPP 11 and PPP 12 and the Inquiry Team is now considering those responses.

PPP 11 and PPP 12 raised concerns that certain Potentially Deficient Features of the ventilation and water systems might have a root in the Building Contract that governed the construction of the QEUH/RHC. This PPP sets out the results of further investigations by the Inquiry Team into that contract, and into the question of whether those Potentially Deficient Features can be linked to the Building Contract (either directly or indirectly) or have been contributed to by the manner in which the Building Contract was implemented by one or either party.

The reader of this PPP should note that when events are described, the companies involved will be referred to by their names at the time. There have been many changes to the identities of the various participants in these events since the Building Contract was negotiated and signed. A list of these organisations and how they relate to each other can be found in Appendix B to this PPP.

1.3 Potentially Relevant Features - Glasgow III[2]/IV[3]

The Inquiry has identified a series of decisions, events and contractual terms as being Potentially Relevant Features ("PRFs") of the procurement history in general and the Building Contract in particular.

The Inquiry intends to consider these PRFs primarily in the Glasgow IV hearing in the spring of 2025. However, since the factual matrix behind some aspects of the PRFs is not, at this stage of the Inquiry, fully understood, witnesses in the Glasgow III hearing may be asked about the events that surrounded some of these PRFs, why certain steps were taken by participants and parties and, importantly, who knew about key decisions, events, and contractual terms.

In particular, Infection Prevention and Control ('IPC') team members working at the QEUH/RHC before the handover of the hospital in January 2015 may be asked in Glasgow III what they knew about the Agreed Ventilation Derogation (see PRF 1 below); whether their views were sought at the time it was agreed; what knowledge they may have of the reasons behind it; and whether in their opinion it contributed to the need for upgrading works subsequently carried out or works that may still be required.

IPC team members working at the QEUH/RHC before the handover of the hospital in January 2015 may also be asked about the extent to which they were consulted about those parts of water and ventilation systems that now appear to amount to Potentially Deficient Features identified in PPP 11 and PPP 12 and when they were so consulted.

[1] As explained in PPP 11 and PPP 12, the defined term of a "defect" under the Building Contract is not the same as the concept of a Potentially Deficient Feature used in the PPPs or the Key Questions identified by the Inquiry Team.
[2] Glasgow III is the Hearing commencing 19 August 2024.
[3] Glasgow IV is the Hearing due to take place in the spring of 2025.

It is intended that a number of members of the NHS GGC Estates Team may give evidence in Glasgow III about events in the months and years that followed handover in January 2015. Many of those witnesses were also in post whilst construction was underway, and some were in post before the Building Contract was agreed. Those witnesses may be asked about when they learned of the Agreed Ventilation Derogation (see PRF 1 below), whether their views were asked for, any knowledge they may have of the reasons behind it and what effect it had on the safe operation of the hospital.

1.4 Potentially Relevant Features

PRF 1: The decision by GGC and Brookfield to enter into a Building Contract under which it was apparently agreed (in a document called the "M&E Clarification Log") that Brookfield would design and deliver a ventilation system for the hospital which, at this stage of the Inquiry's investigations, appears to have been known to, and accepted by, both parties as being (a) not compliant with SHTM 03-01; and/or (b) a derogation from the Employer's Requirements (the "Agreed Ventilation Derogation").

PRF 2: The reasons for the Agreed Ventilation Derogation, in particular why it was agreed in the context of a new build hospital which was described by the then Chair of GGC at its opening on 3 July 2015 as "state-of-the-art", "magnificent new facilities" and "centres of excellence", with the prevention and control of infection a primary consideration in its design and construction.

PRF 3: The extent to which the Agreed Ventilation Derogation was driven by any of the following factors: (a) the decision to choose NEC3 Option C for the contract which meant shared financial consequences for both Brookfield and GGC if target costs (defined in the Building Contract clause 11.2(30)) were exceeded; (b) the late stage (i.e. on or around 15 December 2009, being three days before the Building Contract was signed) at which it appears to have been realised and accepted that the ventilation system designed by Brookfield and described in the Contractor's Tender Return Submission would not comply with SHTM 03-01; (c) the stage at which a decision was made that the building would be sealed or non-sealed; and (d) a contractual agreement that £250,000 would paid to Brookfield if energy targets/BREEAM ratings were achieved by the design.

PRF 4: The ambiguous scope of the Agreed Ventilation Derogation, in particular whether it covered all wards in the QEUH/RHC, including specialist wards and specialist ventilation and isolation rooms then intended to be included in the hospital, and any specialist facilities to be later added to the hospital before it opened.

PRF5: The agreement between Brookfield and GGC to include the Agreed Ventilation Derogation in a contractual document called a "M&E Clarification Log" (while at the same time not expressly amending references in the Employer's Requirements to mandatory compliance with SHTM 03-01) which may have contributed to subsequent lack of awareness of it.

PRF6: The agreement between Brookfield and GGC that the M&E Clarification Log would on a plain reading of the Building Contract take precedence over the Employer's Requirements.

PRF7: The apparent lack of awareness by a wide range of organisations and key individuals of the Agreed Ventilation Derogation, from its agreement in December 2009 to date, apart from Brookfield and a small but currently unknown number of people in GGC.

PRF8: The lack of clarity about how widely the Agreed Ventilation Derogation was consulted on (a) prior to the Building Contract being signed; and (b) during the design development stage between the Building Contract being signed on 18 December 2009 and the Authorisation to Proceed being signed on 16 December 2010.

PRF9: Whether GGC carried out, instructed to be carried out, or was aware of, any formal or informal risk assessment about the risks of the Agreed Ventilation Derogation or other alternative options for the design of a ventilation system that would achieve compliance with SHTM 03-01. The Inquiry holds no evidence to show that a formal risk assessment was carried out.

PRF 10: The omission of any reference to the Agreed Ventilation Derogation in the Full Business Case (FBC) submitted by GGC to Scottish Government.

PRF 11: Whether any lack of knowledge about the Agreed Ventilation Derogation caused opportunities to interrogate or question it to be missed from late 2009 onwards; and whether any of those missed opportunities could have led to upgrading work necessary to ensure compliance with SHTM 03-01 being carried out prior to patients occupying the hospital.

PRF 12: The extent to which GGC's agreement to the Agreed Ventilation Derogation was the principal or a significant cause of the QEUH/RHC being built with the potentially deficient features of the ventilation system identified in PPP 12.

PRF 13: The decision by GGC to reduce the scope of the services provided by their professional team during the construction phase.

PRF 14: The decision by GGC to allow Brookfield to take on the role of Independent Commissioning Engineer.

PRF 15: The lack of independent validation as recommended in NHS Guidance. The QEUH/RHC was therefore not independently validated against national standards before patients began to use the hospital.

PRF 16: Whether GGC adequately assessed the risks and the resource implications of changing the procurement model from PFI to traditional design and build. For example, assessing the importance of commissioning and validation, and ensuring sufficient resources to manage and maintain the hospital post-handover.

1.5 Procedure to be adopted

This PPP is based upon publicly available and other prominent reporting and the Inquiry's investigations across its various workstreams. The principal documents relied upon by the Inquiry Team in preparing this PPP are contained in a new bundle (Bundle 17 – Contract and Procurement) that will be available for the Glasgow III hearing.

In due course, the Chair is likely to be invited by the Inquiry Team to make findings in fact based on the content of this paper. In paragraph 1.6 below, the Inquiry Team has asked specific questions that are relevant to the issues considered in this PPP. In addition to answering these questions it is open to any Core Participant (CP) or indeed any other person holding relevant information, to seek to correct and/or contradict it by way of response. In considering those responses, and in taking forward its investigations, it is therefore possible that the Inquiry's understanding of matters may change. If it is the case that the Inquiry's understanding does change significantly, a revised edition of this paper may be issued in due course.

While it is possible that the matters covered in this paper will be touched upon to a greater or lesser extent at a subsequent hearing held by the Inquiry – something that may also change the Inquiry's understanding of matters – this is not guaranteed. If Core Participants wish to address the issues dealt within in this PPP, then they are invited to do so now. In the absence of a response on a matter, the Chair is likely to be invited by the Inquiry team to make findings in fact based on the content of this PPP.

It should be emphasised that Section 2 of the Inquiries Act 2005 provides that an inquiry is not to rule on, and has no power to determine, any person's civil or criminal liability. Accordingly, in the context of the Scottish Hospitals Inquiry's investigations into the matters falling within its remit in relation to QEUH/RHC, the issue of any liability arising under the Building Contract, or other contractual arrangements including those appointing professional consultants, is not a question for the Inquiry to rule on or determine. The Inquiry understands that the issue of whether there was non-compliance with the Building Contract or other contracts, and the consequences of any non-compliance, are controversial. While nothing in this paper should be taken as seeking to determine what the respective civil liabilities of the parties were or may be, it is clearly impossible for the Inquiry to fulfil its Terms of Reference without having regard to the development of the Building Contract and the related appointments. This PPP's examination of the contractual standards should therefore not be read as offering a view or otherwise commenting on the respective legal rights and obligations of the parties involved; its purpose is to enable the Inquiry to fulfil its Terms of Reference.

1.6 Questions for CPs

The issues covered by this PPP address, to a significant measure, the actions of parties to the Building Contract, the consultants employed by parties and those organisations involved in the strategic definition, preparation and brief, concept design and procurement of the QEUH/RHC. These events took place many years

ago and most of the contractual parties are not natural persons but limited companies or statutory bodies. It is the position of the company or statutory body (as opposed to individual employees or officers) that is sought by these questions. The Inquiry reserves the right to make the questions for specific CPs set out in this PPP (or questions ultimately derived from them) the subject of a notice under section 21(2)(a) of the Inquiries Act 2005.

1.6.1 Questions for all CPs

The narrative

(a) Is the narrative described in Parts 2 (The Building Contract) and 3 (Chronology) accepted as an accurate history of what occurred?

(b) With regard to the Agreed Ventilation Derogation in particular, and subject to the answers given to the specific questions noted below,

(i) are the events around the Agreed Ventilation Derogation correctly described; and

(ii) does this PPP report all relevant contemporaneous communication around the time of the Agreed Ventilation Derogation?

If there are any points in respect of which a CP challenges the description of events, CPs should identify what the points of disagreement are and what evidence exists to support the position taken by the CP.

(c) Are CPs aware of other matters that ought to be part of the narrative? If so, please explain them and refer to what evidence exists (including in existing Inquiry bundles) to support them.

(d) Is the description of the Building Contract terms in this PPP accurate? It is noted that CPs may not accept that the contract terms described in this PPP have been breached.

(e) Are CPs aware of any other features of the Building Contract which should be considered by the Inquiry as being relevant to the water or ventilation systems?

(f) Are CPs of the view that the ventilation and water systems did not, at the time of handover of the QEUH/RHC to NHS GGC in January 2015, comply with all relevant statutory regulations or other applicable recommendations, guidance, or good practice? Is so, when did CPs become aware of this?

Potentially Relevant Features

(g) In respect of the PRFs identified in paragraph 1.4, do Core Participants:

(i) agree that each of the PRFs are relevant to the remit and Terms of Reference of the Inquiry;

(ii) have any comments or explanations which they wish to make in respect of any of the PRFs?

1.6.2 Specific questions for Currie & Brown, Brookfield/Multiplex, IBI Group UK and TUV SUD/Wallace Whittle

(a) Was the ventilation design strategy, at the date of the Contractor's Tender Return Submission (11 September 2009), a mixed mode ventilation system (dependent on a non-sealed building) or a mechanical ventilation system (dependent on a sealed building)?

(b) Do you accept that the design and/or specification of the ventilation system as recorded in the Building Contract, in particular in the M&E Clarification Log, was not compliant with NHS Guidance?

If you accept that it was not compliant, please explain (a) why this design was proposed; and/or (b) why this design was accepted.

If you are of the view that it was compliant, please explain why, with particular reference to SHTM 03-01 2009 (Ventilation Design).

(c) What was the scope of the Agreed Ventilation Derogation recorded in the M&E Clarification Log?

In particular, was it restricted to general wards only? If so, (a) how is this interpretation evidenced within the documentation; and (b) where is the specification located for areas that required specialist ventilation and isolation rooms?

(d) Was GGC aware of the ZBP Ventilation Strategy Paper dated on or around 15 December 2009 (other than potentially being sent a copy for the sole purpose of printing it)?

1.6.3 Specific questions for GGC

(a) Did you understand the ventilation design strategy contained in the Contractor's Tender Return Submission (11 September 2009) to be a mixed mode ventilation system (dependant on a non-sealed building) or a mechanical ventilation system (dependent on a sealed building)?

(b) Do you accept that the design and/or specification of the ventilation system as recorded in the Building Contract, in particular in the M&E Clarification Log, was not compliant with NHS Guidance?

If you accept that it was not compliant, please explain (a) why this design was proposed; and (b) why this design was accepted.

If you of the view that it was compliant, please explain why, with particular reference to SHTM 03-01 2009 (Ventilation Design).

(c) What was the scope of the Agreed Ventilation Derogation recorded in the M&E Clarification Log?

> In particular, was it restricted to general wards only? If so, (a) how is this interpretation evidenced within the documentation; and (b) where is the specification located for areas that required specialist ventilation and isolation rooms?

(d) Was GGC aware of the ZBP Ventilation Strategy Paper dated on or around 15 December 2009 (other than potentially being sent a copy for the sole purpose of printing it)?

(e) What risk assessments (if any), whether in compliance with the standards in HAI Scribe or otherwise, did GGC carry out or have carried out in respect of the change in the ventilation strategy that appears to follow the ZBP Ventilation Strategy Paper dated 15 December 2009?

1.6.4 Specific questions for NHS NSS and the Scottish Government

(a) When did you first become aware of the Agreed Ventilation Derogation?

(b) Were you aware of any risk assessment being carried out in connection with the Agreed Ventilation Derogation? If you have any relevant documents, please provide them.

Please be aware that all responses to this PPP received by the Inquiry will be published on its website as soon as possible after the deadline for responses has passed.

2. PART 2: THE BUILDING CONTRACT

2.1 Introduction

This section of the PPP describes the documents forming the Building Contract entered into for the design and construction of the QEUH/RHC, and the contractual terms within those documents that the Inquiry currently understands may be potentially relevant to the Potentially Deficient Features in Provisional Position Paper 11 titled: "Potentially Deficient Features of the water system of the QEUH/RHC" ("PPP 11") and Provisional Position Paper 12 titled: "Potentially Deficient Features of the ventilation system of the Queen Elizabeth University Hospital And the Royal Hospital for Children" ("PPP 12").

The identification of relevant contract terms in this PPP is not to the exclusion of other terms which may be relevant.

It is possible that documents relevant to this PPP or to the Terms of Reference have not yet been identified by (or are not yet in the possession of) the Inquiry or were not otherwise available when drafting this PPP. Further documents may come to light in CP responses and as the Inquiry continues to fulfil its Terms of Reference.

2.1.1 Contractual agreement to derogate from SHTM 03-01 re ventilation

The Inquiry Team reached the preliminary conclusion in PPP 12 (ventilation) that, within the contract documentation, a document entitled "The M&E Clarification Log (2010 ItP) – Final" was important.

The Inquiry team has now considered that document in the context of the Building Contract. It appears that GGC and Brookfield agreed in the Building Contract signed by them on 18 December 2009 (more specifically in one of the contractual documents called the "M&E Clarification Log") that Brookfield would design and deliver a ventilation system for the hospital which, at this stage of the Inquiry's investigations, appears to have been known to, and accepted by, both parties as being (a) not compliant with SHTM 03-01; and/or (b) a derogation from the Employer's Requirements.

For ease of reference, it is called the "Agreed Ventilation Derogation" in this PPP (see PRF1).

The M&E Clarification Log contains an entry in the section "Bid Submission - Vol 2 drawings": "Board Comment":

> "Ward Air change to be 6AC/HR, currently shown as 2.5 AC/HR which is not in compliance with SHTM 03-01".

Brookfield's response is recorded as:

> "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 corridor). Providing 6 air changes is energy intensive and not necessary."

The agreed position is then noted as:

> "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…Negative pressure to be created in the design solution."

On a plain reading, this appears to apply to the whole hospital. However, the Inquiry is aware that the scope may be restricted only to general wards in the QEUH/RHC as built.

A key purpose of this Part 2 of the PPP (The Building Contract) is to understand (to the extent necessary to answer the Inquiry's remit and Terms of Reference) why this entry in the M&E Clarification Log was agreed and how it is relevant to the Potentially Deficient Features identified in PPPs 11 and 12. To do that, this PPP explores the documents comprising the Building Contract.

2.1.2 Building Contract – production of documents

Building contracts are renowned for the complexity of their legal and technical content as well as the multiple documents which are included in technical appendices and/or incorporated by reference. This PPP draws out those parts of the Building Contract that the Inquiry Team considers of significance to the Inquiry.

The Inquiry will only produce in the bundle relating to this PPP (Bundle 17) those parts of the Building Contract which have been identified as relevant to this PPP. Other parts of the Building Contract (such as Employer's Requirements Volume 2/1 Appendix B Clinical Output Specifications) are produced in the bundles relating to the PPPs in which they are expressly referred to.

2.1.3 Building Contract – key dates and documents

This paragraph briefly highlights the following dates and documents to (a) provide context for more detailed narratives of the Building Contract terms later in this part of the PPP; and (b) ensure that the documents which make up the Building Contract are produced in the bundle relating to this PPP in a logical order.

1 May 2009 - IPCD

Following the advertising of the tender for the construction works, GGC issued to three selected bidders the "Invitation to Participate in Competitive Dialogue" (IPCD).

The IPCD comprised three volumes and multiple appendices containing technical information and drawings. The following are produced:

- **Volume 1 Project Scope and Commercial**[4]. This provided an overview and outlined the scope and commercial parameters of the project. It set out the background to the project, outlined the detailed procurement process and timetable, identified the competitive dialogue process and incorporated the draft construction contract.

- **Volume 2/1 Employer's Requirements**[5]. This set out the technical and clinical requirements of the Board. Three of the appendices are also produced:

  Volume 2/1 Appendix K Design Development (FBC and Overall Design Requirements)[6]
  Volume 2/1 Appendix M M&E (parts 1-7)[7]
  Volume 2/1 Appendix U BREEAM Design Guide[8].

- **Volume 3 Bids Deliverables and Evaluation**[9]. This detailed the range of deliverables required from bidders and the evaluation strategy and scoring approach to be applied by the Board. The scoring approach is outwith the scope of this PPP but will be considered in the Governance PPP.

May to August 2009 - competitive dialogue period

During these four months, GGC and its team of professional advisors met with each of the three selected bidders in a series of 16 scheduled meetings to discuss and clarify the Board's requirements in four main areas of the project: design, site logistics, laboratories, commercial.

[4] A35184454 - IPCD Volume 1 Project Scope and Commercial Document - (iss1 rev1) - May 2009.
[5] A35761303 - IPCD Volume 2/1 Employer's Requirements - May 2009, Bundle for Oral hearing commencing 19 August 2024 - Bundle 16 - Page 1357.
[6] A33010737 - IPCD Volume 2/1 Employer's Requirements Appendix K Design Development - (Updated Revision 1) - May 2009.
[7] A35762133 - IPCD Volume 2/1 Employer's Requirements Appendix M M&E.1 Building Services and Utility Connections - May 2009.
A35762137 - IPCD Volume 2/1 Employer's Requirements Appendix M M&E.2 Base Building Loads - May 2009.
A35185420 - IPCD Volume 2/1 Employer's Requirements Appendix M M&E.3 Plant Strategy and Design Criteria – May 2009, Bundle for Oral hearing commencing 19 August 2024 - Bundle 16 - Page 1592.
A35185421 - IPCD Volume 2/1 Employer's Requirements Appendix M M&E.4 Sustainable Design Considerations - May 2009.
A35185440 - IPCD Volume 2/1 Employer's Requirements Appendix M M&E.5 Integrated Building Management System - May 2009.
A35185464 - IPCD Volume 2/1 Employer's Requirements Appendix M M&E.6 Renal Water - May 2009.
[8] A35761788 - IPCD Volume Employer's Requirements 2/1 Appendix U BREEAM Design Guide - May 2009.
[9] A35186047 - IPCD Volume 3 Bid Deliverables and Evaluation - May 2009.

11 September 2009 - Contractor's Tender Return Submission

Brookfield submitted their Contractor's Tender Return Submission. This is sometimes referred to as the Contractor's Proposals or the Contractor's Tender Return. It comprised 10 volumes. The following three volumes are produced[10]:

- Volume 3 Design Narratives[11]
- Volume 4 Specifications[12]
- Volume 7 SHTM[13]

18 December 2009 - the Building Contract is signed

The Building Contract between Greater Glasgow Health Board and Brookfield was signed on 18 December 2009. As explained in the following paragraphs, this incorporated Volume 2 of the Employer's Requirements and the Contractor's Tender Return Submission as amended by certain documents including documents called logs. The following parts are produced:

- The Agreement[14]
- The Conditions[15]
- The Logs (known as the 2009 Logs to differentiate them from the 2010 versions of the Logs by which they were superseded when the Authorisation to Proceed was signed on 16 December 2010). The Logs were the:

  M&E Clarification Log[16]
  BIW Log[17]
  RFI Log[18]
  Clarification Log [19]
  Laboratory Log [20]
  Sustainability Log[21]

[10] The Contractor's Tender Return Submission is incorporated into the Building Contract, as amended. See the following section of this PPP for more information.
[11] A32758374 - Contractor Submission Volume 3 1-3.33 Design Strategies - 11 September 2009, Bundle for Oral hearing commencing 19 August 2024 - Bundle 18 Volume 1 - Page 205. Note Water Services and Drainage Design Strategy (page 101 of document/page 305 of Bundle 18 Volume 1); Heating Design Strategy (page 103 of document/page 307 of Bundle 18 Volume 1); Ventilation and Air Treatment Design Strategy (page 107 of document/page 311 of Bundle 18 Volume 1).
[12] A33015497 - Contractor Submission Volume 4 Specification 4.5-4.57 - 11 September 2009.
[13] A33015508 - Contractor Submission Volume 7 SHTM Compliance - 11 September 2009.
[14] A32372025 - Agreement between Greater Glasgow Health Board and Brookfield Construction Limited - 18 December 2009.
[15] A35761216 - NEC3 Engineering and Construction Contract June 2005 Option C: Target contract with activity schedule - June 2005.
[16] A48743675 - M&E Clarification Log - 2009.
[17] A35762552 - BIW Log - 2009.
[18] A33010812 - RFI Log - 2009.
[19] A33010815 - Clarification Log - 2009.
[20] Not relevant to this PPP.
[21] A33010809 - Sustainability Log - 2009.

16 December 2010 – Authorisation to Proceed

A year after the Building Contract was signed, Greater Glasgow Health Board issued the Authorisation to Proceed[22] with the construction stage. This document is sometimes referred to as the Instruction to Proceed or ITP. It captured the agreed changes in the design development stage during the previous year and modified the Building Contract in respect of them. It was signed in a form conforming to Appendices 2 and 3 of the Building Contract signed on 18 December 2009. It included 2010 versions of the logs previously agreed in the Building Contract in their 2009 versions.

The following parts are produced:

- The Authorisation to Proceed[23]

- The following Logs known as the 2010 Logs (to differentiate them from the 2009 Logs incorporated into the Building Contract dated 18 December 2009). They were the:

  BIW Log (2010ItP) (FINAL)[24],
  RFI Log (2010ItP) (FINAL)[25],
  Clarification Log (2010ItP) (FINAL) [26],
  M&E Clarification Log (2010ItP) (FINAL)[27],
  Laboratory Log (2010ItP) (FINAL) [28],
  Sustainability Log (2010ItP) (FINAL).[29]
  A new log was also agreed, namely the Stage 3 Instruction to Proceed Log December 2010[30].

The Inquiry is particularly interested in the M&E Clarification Log (2010ItP) - (FINAL)[31].

The Agreement to Proceed states at Clause 3.v. that “Contract Data Part One and Contract Data Part Two forming part of the executed Contract dated 18 December 2009, is amended and supplemented” by the 2010 Logs.

[22] A32421449 - Authorisation to Proceed - 16 December 2010.
[23] A32421449 - Authorisation to Proceed - 16 December 2010.
[24] A35761406 - BIW Log (2010 ItP) FINAL - 2010.
[25] A35761414 - RFI Log (2010 ItP) FINAL- 2010.
[26] A33015736 - Clarification Log (2010 ItP) FINAL - 2010.
[27] A35761409 - M&E Clarification Log (2010 ItP) FINAL - 2010, Bundle for Oral hearing commencing 19 August 2024 - Bundle 16 - Page 1662.
[28] Not relevant to this PPP.
[29] A35761402 - Sustainability Log (2010 ItP) FINAL - 2010.
[30] A35806194 - Instruction to Proceed Log - 2010.
[31] A35761409 - M&E Clarification Log (2010 ItP) FINAL - 2010, Bundle for Oral hearing commencing 19 August 2024 - Bundle 16 - Page 1662.

A 2010 Instruction to Proceed Bible Index[32] was prepared capturing the differences between the Building Contract (18 December 2009) and the Authorisation to Proceed (16 December 2010). It is not known if it was a contract document.

2.2 Documents comprising the Building Contract

Brookfield Construction (UK) Limited ("Brookfield") and Greater Glasgow Health Board ("GGC") entered into a contract for the design and build of the QEUH/RHC dated 18 December 2009 (the "Building Contract"). The Building Contract was for the management and delivery of design and construction services for the New South Glasgow Hospital subsequently known as the QUEH/RHC.

Clause 6 of the Building Contract lists the documents forming part of that contract. These are:

> "6.1 this Agreement
> 6.2 the conditions of contract[33],
> 6.3 Contract Data part one including Works Information – data provided by the Employer
> 6.4 the Contractor's Tender Return Submission dated 10 September 2009 including:
> (i) Contract Data part two – Data provided by the Contractor"

A brief overview of these four elements of the Building Contract is provided below[34].

2.2.1 The Agreement

The four-page main agreement consists of a short preamble and seven clauses.

The preamble sets out that the Employer, Greater Glasgow Health Board, wishes the Contractor, Brookfield Construction (UK) Limited, to provide the Works for the New South Glasgow Hospital comprising "the management and delivery of design and construction services" for four stages of work (i.e. Stages 1, 2, 3 and 3A where only stages 2 and 3 are relevant to this PPP) as defined, i.e.:

Stage	Heading	Outline Activities
1	Design and Construct Laboratories	Detailed design and construction of the Laboratories and FM Hub. Concurrent with Stage 2.

[32] A33018486 - NSGH Instruction to Proceed Bible Index - 2010.
[33] It is a feature of the NEC form of contract that some terms are narrated in italics e.g. "*conditions of contract*", "*works*", "*Employer*", *"Project Manager*", "*Supervisor*". The Contract Data part one states what these terms mean e.g. "*conditions of contract*" is stated to be the core clauses of the NEC form of contract and the clauses for main Option C together with stated additional secondary options (see paragraph 2.2.2 of this PPP); the *Employer* is stated to be Greater Glasgow Health Board; *the Project Manager* is stated to be Peter Moir, the *Supervisor* is stated to be Peter Moir. The contractual clauses which are reproduced in this PPP do not retain the italics. The original clause in the Building Contract should be referred to if the specific contractual meanings of these terms is likely to be of relevance.
[34] It is noted that 'Contract Documents' is a defined term in the Building Contract (per clause 11.2(35) of the Conditions of Contract as amended).

2	Design Development – New Hospitals Building	Detailed design of the New Adult Acute and New Children's Hospitals to Full Business Case Submission. Concurrent with Stage 1.
3	Design and Construct New Hospitals Building	Design and Construction of New Adult Acute and New Children's Hospitals and Energy Centre. Consecutive to Stage 2.
3A	Demolition of Surgery Block	Demolition of surgical block and associated buildings and completion of soft landscaping.

Clause 1 provides that the Contractor "will provide the Works in accordance with the NEC Engineering and Construction Contract, Option C: Target contract with activity schedules, June 2005 (as the same are amended by the Contract Data) ('the conditions of contract') and the principles stated in Appendix 1 of this Agreement."

Clauses 2 to 4 concern the pricing and payment terms for the Stages.

Clause 5 provides that at the Contract Date the contractor is authorised to proceed with Stages 1 and 2 only, and that the contractor would only be authorised to proceed with Stage 3 upon written authority being provided by the Employer (GGC) in the form attached as Appendix 2 to the Building Contract. The effect is that the Building Contract is a "two-stage" contract as a separate authorisation ("Authorisation to Proceed") is required before starting the construction stage. Stage 3 can only commence once the Full Business Case is submitted and approved by the Scottish Government. The Full Business Case is an essential gateway which must be achieved to allow the construction of the hospital to start. It is a significant document in the history of the project. Further details are provided in Part 3 of this PPP (Chronology).

As set out above, clause 6 sets out the documents that form part of the Contract.

The final clause, clause 7, sets out the hierarchy to be given to the different contract documents in the event of conflict. The hierarchy is set out in more detail in the following section of this PPP (paragraph 2.3).

As to the three appendices to the main agreement, Appendix 1 is the "Principles governing the Agreement" and Appendices 2 and 3 are the short (one-page) forms of agreement to be entered into to authorise the contractor to proceed with Stage 3 and Stage 3A, respectively.

After these appendices, at page 13 of the Agreement, the "Contract Data Part One - Data provided by the Employer" (GGC) is provided. This includes six appendices.

The drafters of the NEC3 Option C envisaged that Contract Data part one would form part of the tender documents issued by the Client (i.e. GGC) and then Contract Data part two would be completed as part of the Contractor's (i.e. Brookfield's) tender return.

Contract Data parts one and two appear to be within the definition of the "Agreement". They are considered under separate heads below.

2.2.2 The Conditions of Contract

It is usual for construction contracts to consist of a short form agreement which incorporates standard conditions of contract (such as the conditions from the NEC suite of standard conditions) with bespoke amendments to those standard conditions negotiated between the parties. This is what happened in this Building Contract.

Clause 1 of the main Agreement defines the Conditions of Contract as "the NEC Engineering and Construction Contact, Option C: Target contract with activity schedules, June 2005[35] (as the same are amended in by the Contract Data)."[36] This definition is repeated in clause 11.2(48) of the amended Conditions of Contract.

In the Contract Data part one, the Conditions of Contract are defined as the core clauses and the clauses for main Option X, dispute resolution Option W2 and Secondary Options – X2, X4, X5, X7, X13, X18.5, Y(UK)2 and Z of the NEC3 Standard Form.

The Contract Data part one also sets out various bespoke amendments and additions to those Conditions of Contract clauses.

As to the selection of NEC3 Option C, this pricing model means that there is no contract sum. Rather, a target cost is agreed at the outset, with an incentive to the contractor to achieve or better the target in the form of a share in any savings. The contractor would therefore be paid the defined cost, plus the fee. In addition, it is paid a share of any saving against the target price (or alternatively minus a share of any excess over the target price). The Activity Schedule sets out target costs for the activities making up the works, which may be updated under clause 60 (compensation events) or clause 54.2 of the Conditions of Contract. The defined cost is defined in clause 11.2(23) of the Conditions of Contract as the amount of payments due to subcontractors and the cost of components in the Schedule of Cost Components for other work less Disallowed Cost (as defined in clause 11.2(25).

The selection of Option C has an important impact on risk profile and incentivisation. It requires detailed risk analysis and risk management and a careful setting of both the target cost and the pain/gain share percentages. It may also be important to consider this alongside the defined compensation events and how risk is allocated more broadly (such as in relation to changes to standards or legislation).

The share percentages are stated in clause 5 of Contract Data part one. In essence, under the Building Contract, Brookfield would take the majority of the gain if there was a saving, and (unless overspend was relatively limited) would be liable for the majority of the overspend if the target price was exceeded.

[35] A35761216 - NEC3 Engineering and Construction Contract June 2005 Option C: Target contract with activity schedule - June 2005.
[36] That definition is repeated in clause 11.2(48) of the amendments to the NEC Standard Form.

2.2.3 The Contract Data part one including Works Information – data provided by the Employer

As to "the Contract Data part one including Works Information – data provided by the Employer," the Contract Data part one is set out in the Agreement.

As to what the "Works Information" includes, per the Contract Data part one, it comprises:

> "The Contract Documents: Part Five (Works Information);
> The Employer's Requirements; and
> The Contractor's Proposals including the M&E Clarification Log."

The 'Contract Documents: Part 5 (Works Information)' is understood to be a reference to "Appendix 5 to Contract Data part one: Works Information agreed relationship and hierarchy". There are six appendices to Contract Data part one. The other five appendices are: Appendix 1 – a Form of Consultant's Collateral Warranty; Appendix 2 – a Form of Sub-Contractor's Collateral Warranty; Appendix 3 – a Form of Novation Agreement (including appendixes); Appendix 4 – a Building Contractor's Parent Company Guarantee; and Appendix 6 – a Guarantee Bond.

As previously explained, the Employer's Requirements is a very detailed document. Part of the reason for this is appears to be consideration of the cost implications for bidders, as explained in clause 8.1.5 of the IPCD: "the Board has developed certain levels of Works Information (contained in Volume 2) [of the IPCD, which contain the Employer's Requirements] aimed at minimising transaction time and costs for Bidders."

Note the specific reference in the definition of the "Works Information" to the M&E Clarification Log. It appears to the Inquiry Team that this is a significant contractual document and its impact on the Building Contract and the ventilation system for the hospital that was eventually built is a key theme in this PPP.

2.2.4 Contractor's Tender Return Submission (10 September 2009) including Contract Data part two – Data provided by the Contractor

Brookfield's tender bid also forms part of the Building Contract, including Contract Data part two. The Contractor's Proposals were contained in ten volumes as follows[37]:

- Volume 1: Schedule of Accommodation
- Volume 2: Drawings
- Volume 3: Design Narratives
- Volume 4: Specifications
- Volume 5: Components

[37] As explained earlier, Volumes 3, 4 and 7 are relevant for this PPP and therefore produced in the related Bundle.

- Volume 6: Equipment
- Volume 7: SHTM
- Volume 8: ADB
- Volume 9: Programme
- Volume 10: Logistics
- Volume 11: Not used
- Volume 12: Commercial

2.3 Terms of the Building Contract relating to interpretation and hierarchy of documents

Questions of contractual hierarchy only apply in cases of inconsistency. It is therefore important to read the contractual documents together to see whether, on a proper construction, there is any inconsistency.

2.3.1 The Agreement

Clause 7 of the main Agreement sets out the overarching contractual hierarchy:

> "In the event of conflict between the documents forming part of this contract the following order of priority will apply:
>
> 7.1 This Agreement (excluding Appendix 1)
> 7.2 The conditions of contract,
> 7.3 Contract Data part one including the Works Information
> 7.4 Contract Data part two
> 7.5 Appendix 1 of this Agreement"

Thus, the Agreement (excluding its Appendix 1) is to be given the highest priority in the event of conflict between the Contract Documents.

2.3.2 The Conditions of Contract

Second in the order of priority are the Conditions of Contract (which, as a defined term, includes the amendments). In terms of construction and hierarchy, the Conditions of Contract as amended provide:

> "**12 Interpretation and the law** […]
> 12.4 This contract is the entire agreement between the Parties."
>
> "**Z1 Additions to Clause 11.2 – Identified and Defined Terms** […]
> 11.2(39) 'Employer's Requirement' is the description of the Employer's technical requirements for the works supplemented and amended by the Logs and signed by the parties for identification and deemed to be incorporated in and forming part of this Agreement."
>
> "**Z8 Addition to clause 17 – Ambiguities and inconsistencies**

17.2 The Project Manager and the Contractor agree that inconsistencies and ambiguities between (a) the NHS Mandatory Documentation and NHS Guidance Documentation and building control or (b) between the NHS Mandatory Documentation and NHS Guidance Documentation and the Schedules of Accommodation or (c) between the NHS Mandatory Documentation and NHS Guidance Documentation and any information issued to the Contractor by the Employer, will be dealt with in accordance with the procedures set out in the Works Information."

"**Z51 New Clause – Inconsistencies**
In the case of any inconsistency between these additional conditions of contract and the other terms of the contract, the additional conditions of contract prevail. In the event of any inconsistency between the Core Clauses and any other term of this contact (except these additional conditions of contact) the Core Clauses prevail."

"**Z52 New Clause – Approval**
No inspection, testing, approval or review nor any omission to inspect, test, approve or review on the part of the Employer diminishes any duty or liability under this contract of the Contractor."

2.3.3 The Contract Data part one including Works Information

Below the Conditions of Contract is the Contract Data part one.

Clause 1 of the Contract Data part one provides

"**1. General** […]
The Works Information agreed relationship and hierarchy is set out in Appendix 5 to this Contract Data Part one."

Appendix 5 to Contract data part one therefore determines the priority of documents as between the documents comprising the Works Information.

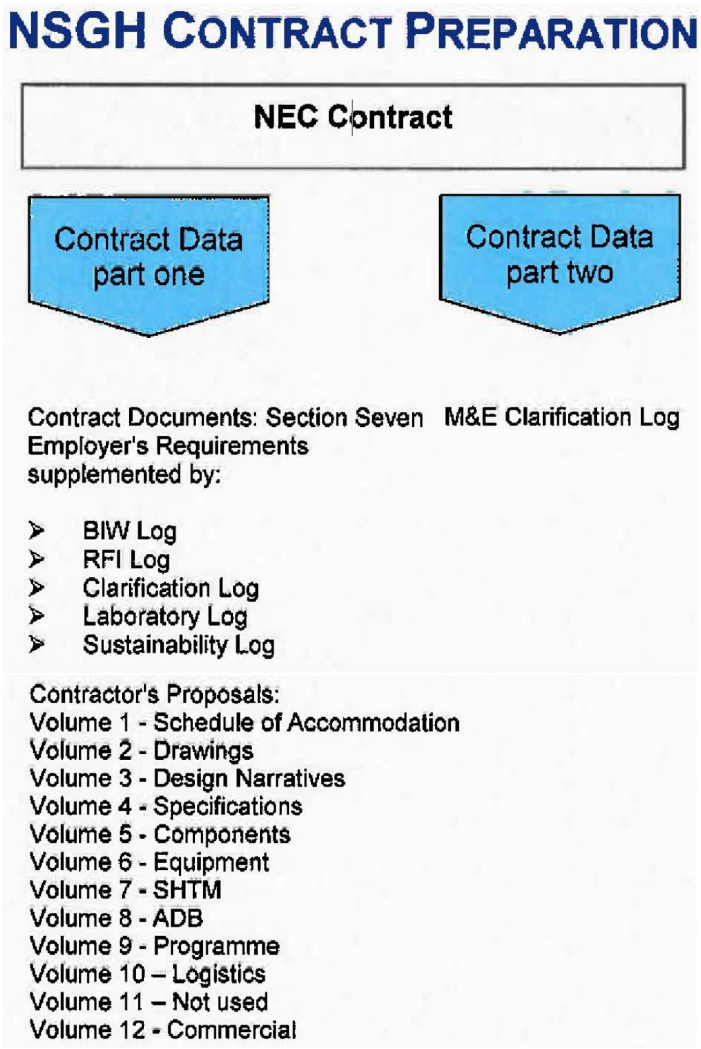
The Inquiry's current understanding is that Appendix 5 is likely to be important to its understanding of the hierarchy of documents. Appendix 5 to Contract data part one provides *inter alia* that:

"**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 Employer's 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 [sic.] 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." (bold added)

It is unclear whether "Request for Information ('RFI'), Additional Log" refers to one log or two logs. The Inquiry has the Request for Information Log but not a document titled 'Additional Log.'

The interpretation of Appendix 5 is considered in more detail in the following sections.

2.4 Terms of the Building Contract relating to design and construction

To put in context the contract terms being referred to below, reference is made below to the potentially deficient features identified of the ventilation and water systems detailed in PPP 12 (ventilation) and PPP 11 (water), respectively.

As to the potentially deficient features regarding ventilation, as set out in PPP 12, these differences appear to have had their roots in, or at least been contributed to by, a decision to build by reference to the M&E Clarification Log rather than the Employer's Requirements which required compliance with SHTM 03-01. The focus in this PPP in relation to ventilation is on the meaning of the design requirements under the Building Contract, including the relevant contractual consequences of the M&E Clarification Log. Reference will also be made to the commissioning and validation requirements, which might have provided opportunities to question departure from SHTM 03-01 in this area.

Whereas the potentially deficient features relating to ventilation primarily concern design standards in SHTM 03-01 (including air change rate and room air pressure), the potentially deficient features relating to water are much broader and relate to various design, installation and maintenance failings and standards in SHTM 04-01, including *inter alia*: selection of materials (sub-standard stainless steel, copper, carbon steel); selection of fittings (taps with flow straighteners and thermostatic mixing devices, flexible hoses, ARJO baths); lack of backflow protection; potential for deadlegs; pipework installation techniques; issues with the energy centre and maintaining water temperatures; lack of flushing; unscreened water tank vents; exposed waste pipes; insufficient control measures and record keeping to monitor system performance; introduction of unfiltered water; and cleanliness issues (with chilled beams, plant rooms, water coolers, shower heads etc). Consideration is given to how the various matters identified in PPP 11 were governed by the Building Contract.

For the avoidance of doubt, statements in this PPP as to the potentially deficient features identified in PPP 11 and PPP 12 are for convenience only and is not intended to amend or depart from those PPPs.

The terms in this section appear potentially relevant to those potentially deficient features, though not to the exclusion of others. This section is intended to provide an overview. The construction and meanings arising from these terms is considered in a later section of this PPP.

In the extracts of the documents referred to below, and in the remainder of this PPP, the Inquiry has highlighted in bold the sections considered to be of particular interest.

2.4.1 The Agreement

The preamble and clause 1 of the main Agreement provide that:

> "WHEREAS
> The Employer wishes to have the Contractor Provide the Works for the New South Glasgow Hospital comprising management and delivery of design and construction services as follows: -
> […]
> Stage 3 Design and Construct New Hospital Building […]
> NOW IT IS AGREED THAT

1. The contractor will provide the Works in accordance with the NEC Engineering and Construction Contract, Option C: Target contract with activity schedule, June 2005 (as the same are amended by the Contract Data) ('the conditions of contract') and the principles stated in Appendix 1 of this Agreement."

Appendix 1 to the Agreement sets out the Principles Governing the Agreement.

The 'Overriding Principle' of the Agreement includes achieving the 'Overriding Objective' which is defined in clause 4 of Appendix 1 as follows:

"4. In entering into the Agreement the parties' Overriding Objective is by working together in accordance with the terms of the Agreement to achieve the successful delivery by the Contractor of the works –

4.1 to the **standard and functionality defined or as reasonably inferred from the Employer's requirements set out in the Works Information to a quality which meets or exceeds these requirements**; (bold added)

4.2 at a cost to the Employer that offers best value for money taking into account whole life (as well as capital) costs over the proposed design life of the works through the application of the principles of value engineering;

4.3 to the timescale acceptable to the Employer and agreed between the parties without compromising health and safety or the Employer's required standards and the quality of the completed works and in any event before the Completion Dates set out in the Agreement; and

4.4 with an appropriate allocation of the risks associated with the works to the party best able to manage such risks."

Further, clause 5 of Appendix 1 provides as follows:

"The Consultant shall carry out the management and be responsible for the delivery, design and construction of the works in accordance with the Agreement and shall work and liaise with the Employer and any of its Professional Advisers as necessary or appropriate or as requested by the Employer in order to achieve the Overriding Objective."

2.4.2 The Conditions of Contract

As to the contractual standard contained in the Conditions of Contract, the following provisions are noted:

"**10 Actions**

10.1 The Employer, the Contractor, the Project Manager and the Supervisor shall act as stated in this contract and in a spirit of mutual trust and co-operation.

11 Identified and defined terms […]

11.2(2) Completion is when the Contractor has

- done all the work which the Works Information states he is to do by the Completion Date and
- corrected any Defects which would have prevented the Employer from using the works and Others from doing their work.

If the work which the Contractor is to do by the Completion Date is not stated in the Works Information, Completion is when the Contractor has done all the work necessary for the Employer to use the works and for Others to do their work.

[…]

11.2(5) A Defect is

- a part of the works which is not in accordance with the Works Information
  or
- a part of the works designed by the Contractor which is not in accordance with the applicable law or the Contractor's design which the Project Manager has accepted.

[…]

11.2(13) To Provide the Works means to do the work necessary to complete the works in accordance with this contract and all incidental work, services and actions which this contract requires".

11.2(39) "Employer's Requirements" is the description of the Employer's technical requirements for the works supplemented and amended by the Logs and signed by the parties for verifications and deemed to be incorporated in and forming part of this Agreement".[38]

"**14 The Project Manager and the Supervisor**

14.1 The Project Manager's or the Supervisor's acceptance of a communication from the Contractor or of his work does not change the Contractor's responsibility to provide the Works or his liability for his design."

"**20 Providing the Works**

20.1 The Contractor Provides the Works in accordance with the Works Information.

[38] Bespoke amendment to the Conditions agreed in the Agreement.

20.3 The Contractor advises the Project Manager on the practical implications of the design of the works and on subcontracting arrangements."

"**21 The Contractor's design**

21.1 The Contractor designs the parts of the works which the Works Information states he is to design using the degree of skill and care that would reasonably be expected of a competent professional design and build contractor experienced in carrying out projects of a similar nature, scope and complexity to those comprised in the works.[39]

21.2 The Contractor submits the particulars of his design as the Works Information requires to the Project Manager for acceptance. The Project Manager either accepts the design or rejects it and notifies the contractor of his reasons for doing so within the period of reply to the Contractor's submission of particulars of his design for acceptance.[40]A reason for not accepting the Contractor's design is that is does not comply with either the Works Information or the applicable law.

The Contractor does not proceed with the relevant work until the Project Manager has accepted his design.[41]"

"**26 Subcontracting**

26.1 If the Contractor subcontracts work, he is responsible for Providing the Works as if he had not subcontracted. This contract applies as if a Subcontractor's employees and equipment were the Contractor's."

"**30 Starting, completion and Key Dates**

30.1 The Contractor does not start work on the Site until the first access date and does the work so that Completion is on or before the Contract date."

Option X15 of the Conditions of Contract does **not** apply (per clause 1 of Contract Data part one). Option X15 provides that: "The contractor is not liable for Defects in the works due to his design so far as he proves that he used reasonable skill and care to ensure that his design complied with the Works Information."

As to the two-limbed definition of "*Defect*" under clause 11.2(5), it is noted that:

- the definition excludes defects which are due to design for which the employer is responsible (as that would form part of the Works Information); and

[39] Bespoke amendment to the Conditions agreed in the Agreement.
[40] The second sentence of 21.2 is a bespoke amendment to the Conditions agreed in the Agreement.
[41] Further amendments to this clause of the Conditions relate to the failure of the Project Manager to accept the design or reject it can be viewed in the Agreement.

- the definition also excludes defects in the works which are due to the contractor's own design if the Project Manager has accepted the design, and if the design and the relevant part of the works complied with the Works Information.

2.4.3 Contract Data part one including the Works Information

As set out above, the Works Information is defined as comprising the Contract Documents: Part Five (Works Information), the Employer's Requirements, and the Contractor's Proposals including the M&E Clarification Log.

Contract Documents: Part Five (Works Information)

The Inquiry's current understanding is that the reference to "Contract Documents: Part Five (Works Information)" as being part of the Works Information refers to Appendix 5 of Contract Data part one.

Part of Appendix 5 was set out in an earlier section of this PPP, as it relates to the relationship and hierarchy of the other items comprising the Works Information.

The final paragraph of Appendix 5 starts with "The process for review of design to be submitted by the Contractor in relation to the Contractor's Proposals to ensure that it meets the Employer's Requirements is appended to this document as Appendix A."

A document titled "Reviewable Design Data" is attached (though it is titled "Appendix 1"). It sets out the Design Development Process, whereby at each review the Board would "consider the design information provided by the contractor, against the Works Information."

The Reviewable Design Data document provides that during the Design Development Process all information would be subject to review in three categories: for approval, for acceptance, for comment. This procedure would be "used to review and approve/accept/comment, as appropriate a range of deliverables such as clinical functionality at department and room level, specifications including finishes, colour schemes, and materials and components".

Responses would be status coded: "A – no comment, proceed to construction; B- comments but proceed to construction taking comments on board; C - comments resubmit with amendments; D- rejected."

The process set out includes that the Board "will ensure that all responses are signed off by the appropriate staff, to record user and managerial acceptance of the design element under review." It appears to provide that the review focus is on "clinical functionality" the meaning of which is set out in the document and includes matters (a) to (g), including "infection control" and other matters but "only insofar as each of the matters […] relate to clinical use."

The document attaches a table which is said to indicate "the proposed extent for Approval and Acceptance with all other data being for comment." Table 1 is titled "New South Glasgow Hospitals List of Data for Review" which includes a list of "Drawing Information" and a list of "Design Information." The list of Design Information including inter alia "Plumbing fittings/tapware," "Schedules of components for M&E" and "Mechanical & Electrical drawings." The final line of the table states that the "above is in addition to key design requirements as set out in SHTMs and advisory documentation as included in Volume 7."

The document states that the list in Table 1 sets out the "proposed extent" of data to be for comment in the design review process, but that that list is a "minimum requirement" and that "a final agreed list will be prepared jointly within 2 calendar months of contract execution".

Employer's Requirements

Volume 2 of the Employer's Requirements comprises Volume 2/1 relating to the hospitals and Volume 2/2 relating to the laboratories. It sets out the technical and clinical requirements, including by Clinical Output Specifications. The Employer's Requirements were together Volume 2 of the Invitation to Participate in Competitive Dialogue. (Volume 1 and 3 of the IPCD are not part of the Building Contract and are therefore not set out here. Volume 1 contained the Project Scope and Commercial Document and Volume 3 contained details of the bid return and evaluation).

As to Volume 2/1, GGC's requirements included the following paragraphs which have been identified as relevant to this PPP.

As elsewhere in this PPP, certain text has been put in bold to emphasise relevant parts.

> "**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. […] 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 the requirements of the Board stated in the **Works Information**, Site Information and Employer's Requirements as **a minimum requirement**; […]

2.2.5 Working with the Board and its advisors in fulfilling all of the requirements and good practice inherent in the NEC3 contract; […]

2.2.10 Procuring that the Works are at all times performed: […]

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 accordance with all British and European Standards; and

h. In accordance with **Good Industry Practice**."

"4. 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; […]

"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. […]"

"**4.2.9 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**. […]

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."

"**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. […]

5.1.1.9 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."

The documents relating to water, ventilation and infection prevention and control in Table 2, which the Board considers to be mandatory, include: 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; 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; 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; SHTM 2030 Washer disinfectors.

The documents relating to water, ventilation and infection prevention and control in Table 3, which the Board considers to be guidance, include: SHGN Safe hot water and surface temperatures; SHTN 2 Domestic Hot and Cold Water Systems for Scottish Health Care Premises; HBN 04 Supp Isolation facilities in acute settings.

Clause 5.1.4.1. also requires the contractor to comply with all law and consents, as well as additional standards including Current British Standards, European Standards, and Codes of Practice.

"**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.

5.2.4 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**."

"**5.5 Sustainability**

5.5.1 […] The Board has targeted an 'Excellent' BREEAM rating for the Project. […]"

"**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; […]

b) Ventilation system – including the use of natural ventilation in relation to the affect by neighbourhood sources of environmental pollution; […]

i) Water systems; […]"

"**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.

[…]

5.8.6 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 […]"

"**5.9 Materials**

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.

5.9.6 The Contractor shall not specify or include products or materials that do not comply with relevant British or European Standards, Codes of Practice […]

"**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 […].

5.10.4 **The Contractor shall submit a Mandatory Variant bid providing for a Maximum Temperature provision (26degC)."**

"5.14 Design Development

[…]

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."

"5.15 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."

"**6.0 Construction Phase Requirements**

6.3 Workmanship, Construction Accuracy and 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."

"**6.7 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 […]."

[…]

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;

[…]

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;

[…]

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.;

[…]

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; […]"

"**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.

[…]

b) Pre-Completion Commissioning

iv) The Board's Commissioning shall comprise the activities identified as such in Table A Commissioning – Outline Commissioning Programme;

[…]

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);

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.

[…]

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**

6.8.4.2 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:

6.8.5.5 The Mechanical and Electrical plant and systems operate satisfactorily in accordance with the specified design criteria, and the ADB Room Data Sheet;

[….]

6.8.5.11 All internal and external drainage systems are installed and are operational;

[…]

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: […]

"**7.6 Windows** […]

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; […]
d) all windows (in a naturally ventilated building solution) to have robustly controlled, limited openings -…]
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 so far as practicable. This required to address seasonal changes, where

external temperatures may dictate that it is not desirable to open windows to achieve ventilation. […]

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 armament has been selected to optimise thermal comfort with due consideration to any restrictions on openings. […]

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;"

"**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."

"**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. […]

8.1.1.3 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. […]

8.1.1.10. 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. […]

8.1.1.19. 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. […]

8.1.3.10. 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.

[…]

8.1.5.9. No exposed pipework shall be visible in clinical areas."

"**8.1.6. Energy Targets**

8.1.6.2. The Contractor shall comply with the requirements relating to energy targets as specified in Appendix M&E 4. […]

8.1.6.7. 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: […]

e) Flow restrictors (if risk assessment accepted)."

"**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

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**. […]

8.1.8.6**. Consideration shall be given to the odours from the adjacent sewage works** and appropriate filtration shall be included to reduce odours entering the facility.

[…]

8.1.13. 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."

"**8.1.18. Site Mains Water, Fire Water, Quality & Distribution** […]

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. […]

8.1.20.4. Irrespective of the option proposed by the Contractor the availability criteria described elsewhere in this document must be strictly adhered to."

"**8.1.25. 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**.1.26 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:

c) Requirements **of SHTN's** and SHBNs; […]"

"**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**."

"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.**

[…] Water Systems and Filtration.

[…] Ventilation and Air Conditioning.

[…] High Specification Air Conditioning Systems."

"**8.2.8. Water Systems and Filtration**

8.2.8.1. Cold Water Supply […]

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) **SHTM 04-01**;
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.

[…]

8.2.8.13. 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**. […]

8.2.8.16. 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.

"**8.2.9. 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 [hot water system] 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."

"**8.2.11. Ventilation & Air Conditioning** […]

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.

[…]

8.2.11.8. **Air changes shall be in accordance with CIBSE guides, SHTM's**, HTM's and Building Regulations.

8.2.11.12. Ensure that ventilation systems installed in areas classified as hazardous are designed to relevant standards."

[…]

8.2.14. Ventilation of Isolation Rooms

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."

"**8.2.18. 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."

"**8.2.28. Testing and Commissioning of Mechanical Services** […]

8.2.28.2. **The Contractor shall appoint an independent Commissioning Engineer to manage the Testing and Commissioning as detailed in Appendix M&E3**."

"**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.

12.3 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**."

Appendix M & E to Vol 2 of the ERs

Before turning to the appendixes to the Employer's Requirements below, the Contents page of Volume 2/1 of the Employer's Requirements set out that there are appendixes A to L. Appendix K refers to "Design Development (FBC Requirements)." The Appendices referred to below are all "M&E" appendixes.

Volume 2/1 Appendix M&E 1 to the Employer's Requirements provides that

"**5.3 Filtered Water**

The full water requirement for the Hospitals and Laboratories shall be filtered in accordance with Section 8 of the Employers requirements."

Volume 2/1 Appendix M&E 3 to the Employer's Requirements provides that

"**2.2.12 Water Filtration Equipment**

Water filtration equipment shall be provided in accordance with the current SHBN, and will be located in the Energy Centre. Filtration shall be introduced to; ensure the domestic water supply and hence all associated pipework is maintained at a high standard of cleanliness, from the supply point to all the potable water outlets, it will also prevent build-up in water systems of sediments and deleterious biofilms, which may act as nutrient sources for bacteria. The plant shall be provided with a gas backwash facility. A suitable compressor and air receiver shall be provided to operate the air blowback system all located in close proximity to the water filtration equipment. Filtration should not be a requirement for incoming water destined for non-domestic use, such as fire fighting, boiler feed or other chemically treated or dosed systems."

"**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."

"**2.19 Storage Tanks**

A water treatment regime shall be put in place and carried out to ensure that the water storage does not harbour Legionella all in accordance with the SHTM's."

"**2.26 Schedule of Pipeline Materials** […]

(l) Stainless Steel Pipework for H&C water services."

"**5.2 Commissioning Engineer**

An independent Commissioning Engineer shall be appointed by the Contractor. The Commissioning Engineer shall be responsible for fully managing the commissioning process for the Electrical and Mechanical, Public Health, Medical Gases, Life Safety and communications Installations and shall carry out all necessary liaison with other Contractors and specialist installers and compile the operation and maintenance manuals. The role of the Commissioning Engineer is to assist the Project Manager in providing the Employer with engineering services that perform effectively. […]"

Volume 2/1 Appendix M&E 4 to the Employer's Requirements provides that:

> "**2. General Obligations and Objectives**
> **The sustainability and low carbon designs are fundamental to the design quality evaluation of the project and bids will be scored significantly on these aspects.** This section sets out the requirements.
>
> A BREEAM "Excellent" is a fundamental requirement and achievement of the final rating, as defined in later sections, will be part of the building acceptance procedure. Furthermore, there is a requirement for a Low Carbon design process which will be monitored and evaluated by a Carbon Trust accredited consultant. There are both design and operational energy targets which are to be met as part of the building acceptance procedures…
>
> It is the contractor's responsibility to provide commentary and clear proposals in the submission on any actual or perceived conflicts in requirements"
>
> […]"

> "**3.3.7 Summertime overheat - design considerations**
> 1. **The use of mechanical cooling shall be avoided wherever possible. HTM 03-01 requires that "patient areas only should not exceed 28Cdb for more than 50 hours per annum**" but also that "it can generally be assumed that for a naturally ventilated building, the internal temperature will be approximately 3 K above the external shade temperature. For a building with simple mechanical ventilation, the internal temperature can never be less than the external shade temperature and will invariably be higher. Where calculations indicate that internal temperatures will exceed the selected design for a period that exceeds the building design risk, methods of reducing temperature rise should be implemented. […]"

Removal of Maximum Temperature Variant

The Inquiry notes at this point of the PPP that, on 8 June 2009, (after the issue of the IPCD in May and before Brookfield's Tender Return Submission in September) NHS GGC issued a revision called NSGACL Removal of Maximum Temperature Variant_iss1_rev." [42] It is a contract document.

> "Removal of Mandatory Maximum Temperature Variant.

[42] A33010775 - Removal of Mandatory Maximum Temperature Variant - June 2009.

> 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 C02 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 18oC in winter for longer than 2 hours at a time, or higher than 26oC in summer for more than 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 bidders' attention is drawn to the Employer's Requirements and in particular the following sections…"

The bidders' attention is then drawn to various extracts from Appendix M&E3 of the Employer's Requirements.

The Inquiry understands that the issue of this revision to the Employer's Requirements may have been a relevant factor behind the Agreed Ventilation Derogation. Further information is provided in paragraphs 3.20.2 and 3.23.3 of this PPP.

Appendix U to Vol 2 of the ERs

Appendix U to the Employer's Requirements was called "BREEAM Design Guide". Appendix U is extensive at 107 pages. The whole document is referred to, however the following paragraphs are noted:

> "…The sustainability and low carbon design are fundamental to the design quality evaluation of the project and bids will be scored significantly on these aspects…" (page 2)
>
> "…The sustainability and low carbon design are fundamental to the design quality evaluation of the project and bids will be scored significantly on these aspects. This section sets out the guidance in relation to the detailed BREAAM requirements and processes and is intended to provide assistance to the bidders in the requirements necessary to achieve a BREEAM "Excellent" rating..." (page 2)
>
> "... A BREEAM "Excellent" rating is a fundamental Board requirement and achievement of the final rating as detailed above, will be part of the building acceptance procedure…" (page 2)

"Note that this Appendix overlaps/interacts with the following sections of the Employers Requirements:

- Section 7 – Architectural Requirements
- Section 8, Building Services Requirements, with particular reference to Appendix M, M&E4 – Sustainability & Energy Targets
- Section 9 – Civil & Structural Engineering requirements

and it is the Contractors responsibility to provide commentary and clear proposals in the submission on any actual or perceived conflicts in requirements." (page 2)

"Hea 8 **– Indoor air quality**
[…]

- The building should be designed to provide fresh air rates to dilute pollutants in accordance with the following good practice:
  a. ….
  b. **All clinical areas with controlled environmental conditions comply with HTM 03-01 "Specialised ventilation for healthcare premises**".

"Hea 12 – Microbial contamination

- All water systems in the building should be designed in compliance with the measures outlined in the following standards:

  a. **HTM 04-01** "The control of Legionella, hygiene, "safe" hot water, cold water and drinking water systems"

  b. Health and Safety Executive's "Legionnaires' disease - The control of legionella bacteria in water systems". Approved Code of Practice and guidance, 2008…"

It may also be of note that in Volume 1 of the IPCD (which is not a contract document), the document provides that "The Employer's design aims, functionality requirements and design brief for the contract are described in ITPD Volume 2 Employer's Requirements" and that "The Employer accepts no design responsibility for design issues with the ITPC."

The Logs

Clause 11.2 (39) of the Agreement says that "Employer's Requirement" is the description of the Employer's technical requirements for the works supplemented and amended by the Logs and signed by the parties for identification and deemed to be incorporated in and forming part of this Agreement"".

Appendix 5 to Contract Data part one also makes clear that the Employer's Requirements are supplemented by the Logs – namely the Building Information

Warehouse ("BIW") Log, Request for Information (RFI") Log, [Additional Log] and Clarification Log, Laboratory Log and Sustainability Log.

Also note Part 2 Section C relating to the hierarchy of the Logs, in particular the priority of the M&E Clarification Log over the Employer's Requirements.

The Clarification Log is of note as under Technical Clarification 2 the Board asked Brookfield to "Please indicate any deviations from the M&E elements on the Employer's Requirements." In response, Brookfield stated "The following deviations are proposed" and listed six items. In relation to each item, the Board responded, either to "refer to" the M&E Clarification Log, the RFI Log, the Instruction to Proceed Log or the Instruction to Proceed Project Bible. The six derogations listed by Brookfield on the Clarification Log do not mention the derogations raised in PPPs 11 and 12.

2.4.4 Contract Data part two

M&E Clarification Log

It is unclear where the M&E Clarification Log is in fact located in terms of the compilation of the Building Contract given that Appendix 5 refers to it being located both in Volume 3 of the Employer's Requirements and also in Contract Data part two. For ease of reference, the Inquiry for present purposes has set out the M&E Clarification Log as being part of Contract Data part two, though it may be that it is in fact not in Contract Data part two but in the Employer's Requirements.

As set out in PPP12, the M&E Clarification Log appears to be the basis for the derogation from SHTM 03-01 in the ventilation system design.

The key line of the M&E Clarification Log is set out below (bold added):

Board Comment	Status	Brookfield Comment	Board Comment 2	Agreed Position 2009 Contract	2010 ItP Comments	Agreed position 2010ItP
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**		**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 to	Energy model based on the agreed 2009 position.	**Agreed**

		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 corridor). **Providing 6 air changes is energy intensive and not necessary.**		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.		

It is unclear which specific part of the Contractor's Tender Return Submission is being referred in the M&E Clarification Log as "currently shown as" an air change rate of 2.5AC/HR. It is possible that is related to the Bid Submission Clarification document dated 17 December 2009 (see paragraph 3.23.2 of this PPP for more information).

Contractors Tender Return Submission Vol 3 (Design Narratives)

Ventilation

Volume 3 of the Contractor's Tender Return Submission ("Design Narratives) sets out the "Ventilation and Air Treatment Design Strategy."[43] After noting its view that "the main benefit of employing a natural ventilation strategy in the hospital building is the reduction in energy consumption," Brookfield set out its analysis of the ventilation strategy which is said to be "based on an amendment to the ITFD documents which stated that the overheating threshold was to be set at '50 hours per year above 26ºC'." Brookfield states that it carried out simulations using different design criteria and options to be able to reach a final solution on ventilation. The simulations appeared to show that there would be overheating on 60% of elevations on the mid floor wards and on 100% of top floor wards where mechanical ventilation was at 15 litres per second. The specification noted that "There is no natural ventilation provided on the top floor wards to avoid nuisance from helicopter noise and downdraft."

As to the issue with the problem of odours from the adjacent sewage works, the analysis set out that in association with the design of the mechanical ventilation the

[43] A32758374 - Contractor Submission Volume 3 1-3.33 Design Strategies, - 11 September 2009 at p.107-108, Bundle for Oral hearing commencing 19 August 2024 - Bundle 18 Volume 1 - Page 205.

issue “has been addressed with the provision of carbon filters on the fresh air side of the air handling units.”

The design analysis concluded that:

> “in the wards a mixed mode, natural and mechanical ventilation combination, together with optimising the glazing area and type does not provide the solution to meeting the overheating criteria in the majority of the rooms. It is proposed that all ward rooms be provided with a means of mechanical cooling in the form of an active chilled beam as pictured below. The active chilled beams operate most effectively with the windows sealed as this reduces the likely hood of condensation.
>
> With the overheating design target set at ‘50 hours per year above 26ºC’ and the summer external design temperature also 26°C the target is an onerous one to achieve with natural ventilation. In progressing the ventilation design strategy a number of calculations have been carried using ‘50 hours per year above 28ºC’ (in accordance with the guidance in SHTM 03-01) as the target and it has been found that the mixed mode method is a feasible solution in the majority of the ward rooms.”

Volume 3 of the Contractor’s Proposals also set out the need for the Health Board to undertake maintenance of the ventilation.[44]

Water

The Cold Water Services design envisaged for incoming mains water to be filtered into bulk storage tanks, where it would be stored in a ‘wholesome’ condition. From there it would be distributed throughout the domestic cold water system, thus avoiding the need for a separate drinking water distribution system. Cold water would pass through electronic water conditioning devices to reduce the build-up of scale within equipment and distribution systems. Measures would be in place to regulate scale and pressure, together with capacity for cleaning and treatment. The domestic hot water system was envisaged to be fed from the domestic cold water system, thereby existing at pressure, with further mechanisms or configurations to regulate pressure, to control temperature and flow and risk from contamination, and to minimise risk from scalding.[45]

Contractors Tender Return Submission Vol 4 (Specifications)[46]

Ventilation

[44] A32758374 - Contractor Submission Volume 3 1-3.33 Design Strategies, - 11 September 2009 at p.288, Bundle for Oral hearing commencing 19 August 2024 - Bundle 18 Volume 1 - Page 205.
[45] A32758374 - Contractor Submission Volume 3 1-3.33 Design Strategies, - 11 September 2009 at p.101-102, Bundle for Oral hearing commencing 19 August 2024 - Bundle 18 Volume 1 - Page 205.
[46] A33015497 - Contractor Submission Volume 4 Specification 4.5-4.57 - 11 September 2009, Page 47 to 50 of PDF.

Volume 4 (Specifications) of the Contractor's Tender Return Submission included a section called "Specification for Ventilating Systems". The whole section is referred to, however it is noted that:

- mechanical ventilation and air conditioning systems will comply with the relevant clauses of various guidance documents in including SHTM 03-01;

- both natural ventilation via openable windows in perimeter rooms, and mechanical ventilation in internal rooms and certain perimeter rooms will be used;

- "Absolute HEPA (high efficiency particulate air) terminal filters will be provided only for 'ultra clean' areas such as UCV Theatres and Pharmacy Aseptic Suite. Consideration will be given to installing HEPA filters on plants serving vulnerable patients to afford additional protection against air-borne contamination, e.g. Aspergillus."

- "Air pressure regimes for theatre suites will be designed in accordance with the guidance provided in SHTM 03-1 employing wall mounted pressure control valves. Air volumes will be established by consideration of heat gains or losses and also the air change rate necessary for comfort and safety as appropriate for the activity carried out in each area. Relative air pressures between rooms will be maintained to suit the activity concerned, by design of the supply and extract air volumes, and use of pressure relief equipment where necessary to prevent cross infection or transfer of unpleasant odours between areas, as required by the ADB sheets."

- Descriptions are given of typical ventilation systems including Wards, Isolation Rooms, and "Critical Care departments such as ITU/HDU will be provided with dedicated ventilation systems"

Water

The corresponding section for the Cold Water and Hot Water Services is to be found at pages 37-39. It envisages particularly that both Water Services will conform to NHS Model Engineering Specification Parts C01, C02 C07, C82, D08, addendums to Part C, SHTN 02, SHTM 2027, BS 6700, with Cold Water Services additionally specifying SHTM 2040 and HTM 04-01 6700. Among the specific provisions for cold water were a modification/reduction of storage capacity, and the incorporation of filtering for all incoming water to 0.2 microns. Devices and other measures were to be in place to regulate issues such as pressure, isolation, backflow, monitoring, and special filtration where appropriate. For hot water the configuration of the system was envisaged to be such as to regulate pressure, temperature and contamination, and to be designed to minimise the presence of 'dead leg' areas which would not see regular flow.[47]

[47] A33015497 - Contractor Submission Volume 4 Specification 4.5-4.57 - 11 September 2009, at p. 37-39.

Volume 7 ("SHTM") of the Contractor's Tender Return Submission included a document titled "NHS Mandatory Documentation" which sets out a table summarising whether the bid complied with the NHS guidance which was listed as mandatory in clause 5.1.2 of the Employer's Requirements.

Brookfield states that its bid complied with all the mandatory guidance referred to in PPPs 11 and 12 (including inter alia: HTM 03-01; HTM 03-01 Part B; HTM 03-01 Part A; SHTM 03-01 Part A; SHTM 03-01 Part B; HTM 04-01 Part A; HTM 04-01 Part B; SHTM 04-01 Part A; SHTM 04-01 Part B).

Ventilation

Further in Volume 7, the Contractor's Proposals sets out the "Specification for Ventillating Systems"[48] as follows:

> "The mechanical ventilation and air conditioning systems will comply with the relevant clauses of the NHS Model Engineering Specification Parts C04, C82, addendums to Part C, HVAC DW144, 154, TR19, SHTM 03-1, HTM 05-1, BS 5726 (updated), and descriptions and requirements set out below."

> "Wherever possible, natural ventilation via openable windows will be provided in perimeter rooms."

> "The Hospital will be mechanically ventilated throughout all internal rooms with no access to natural ventilation, perimeter areas where mechanical ventilation is required for clinical and operational and environmental control reasons and deep plan perimeter areas where necessary to assist the natural ventilation. […]."

> "Active chilled beams and fan coil units will also be 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. […]."

> "[…] Consideration will be given to installing HEPA filters on plants serving vulnerable patients to afford additional protection against air-borne contamination, e.g. Aspergillus."

> "Air pressure regimes for theatre suites will be designed in accordance with the guidance provided in SHTM 03-1 employing wall mounted pressure control valves.

> **Air volumes will be established by consideration of heat gains or losses and also the air change rate necessary for comfort and safety as appropriate for the activity carried out in each area**. Relative air pressures

[48] A33015497 - Contractor Submission Volume 4 Specification 4.5-4.57 - 11 September 2009, at p. 47.

between rooms will be maintained to suit the activity concerned, by design of the supply and extract air volumes, and use of pressure relief equipment where necessary to prevent cross infection or transfer of unpleasant odours between areas, as required by the ADB sheets."

Water

Volume 7 also describes the specification of the water system in the following terms:

> "Hot and cold water services are described in Design Strategy for Hot and Cold Water Services Volume 3 Section 3.7 and specification sections Volume 4 Sections 4.27, 4.28 & 4.51. However, the following adjustments are proposed: - Fig 2 shows A small CWS break cistern serving each cold water system, prior to the main filtration plant will be provided. However, a secondary break cistern before each bulk storage cistern will not be provided. At least two equally sized bulk storage cisterns with a total of 100% of the design capacity in each location have been provided. The recommended quantities of water storage given in Table A1 are considered excessive for modern hospitals. Therefore, reduced levels have been used. Refer to Design Strategy for Hot and Cold Water Services Volume 3 Section 3.7 for further details. Clauses 9.13/9.23 recommend providing peak continuous hot water output for 20 minutes. Following the recommendations of the SHTM, results in excessive storage capacity, which can increase energy consumption and increase the risk of Legionella, the HTM approach is also outdated and relates back to when there was high usage of baths at set periods of the day. Modern hospitals predominantly use showers, which use less water and have a much higher diversity factor. This approach will not be followed, but diversity will be considered using the principles of BS 6700." [49]

[49] A33015497 - Contractor Submission Volume 4 Specification 4.5-4.57 - 11 September 2009, at p.9.

3. PART 3: CHRONOLOGICAL NARRATIVE

An outline of the history behind the delivery of the QEUH/RHC is described by NHS GGC on their website: “Building the Hospital: Why was the site chosen”[50].

A more detailed history is contained in NHS GGC’s Outline Business Case[51] (and appendices[52]) dated February 2008 and their Full Business Case[53] (and appendices[54]) dated October 2010, both of which are referred in greater detail in the narrative below.

The following events have been highlighted for the purposes of this PPP.

Pre 2006

3.1 Acute Services Review and Strategy

Between 1998 and 2001, NHS Greater Glasgow undertook an Acute Services Review[55]. The review was intended to develop a strategy to address challenges facing the delivery of acute services in Glasgow. The Acute Services Review culminated in the Acute Services Strategy being approved by the Scottish Government in June 2002.

The second phase of the Acute Services Strategy involved the development of the new South Glasgow Hospital Campus (later known as the Queen Elizabeth University Hospital) “which not only sees the single biggest phase of modernisation and rationalisation of [NHS GGC’s] adult clinical services but incorporates the creation of a new Children’s Hospital for the Greater Glasgow and West of Scotland populations and the completion of the modernisation of Glasgow’s Maternity Services”.[56]

A 1109 bedded adult new build acute hospital was planned to provide A&E services, acute specialist in patient care, a small volume of medical day cases and out -patient clinics serving the local population. The proposed new 240 bedded children’s hospital would 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 proposed New Laboratory build would provide biochemistry,

[50] A49125059 - NHS GGC Webpage “Building The Hospital - Queen Elizabeth University Hospital and Royal Hospital for Children - Why the site was chosen” - downloaded 27 June 2024.
[51] A35289377 - NHS GGC Outline Business Case (public version) - February 2008.
[52] A35289470 - NHS GCC Outline Business Case Appendices (public version) - February 2008.
[53] A35100876 - NHS GGC Full Business Case (public version) – October 2010 (profiled January 2011), Bundle for Oral hearing commencing 19 August 2024 - Bundle 18 Volume 1 - Page 629.
[54] A32691394 - NHS GGC Full Business Case Appendices - October 2011.
[55] The Inquiry does not currently hold a copy of this Review. It is described in the Outline and Final Business Cases.
[56] A35289377 - NHS GGC Outline Business Case (public version) - February 2008, at p.11.

haematology blood transfusion and mortuary services[57]. The expected benefits of the project were many, ranging from the provision of high quality services to "Modern, fit for purpose facilities which meet the needs of patients, visitors and staff".[58]

3.2 Selection of the Southern General Hospital site

The Inquiry is aware that suggestions have been made that the selection of the site at the Southern General Hospital Site had a bearing on issues relating to infection control and the decision to design the hospital with sealed windows and a mechanical ventilation system.

In 2019, the Scottish Government instructed a Review which included a review of the site selection process. Chapter 3 of the Queen Elizabeth University Hospital Independent Report[59] is referred to, in particular paragraph 3.7 "Conclusions"

> "3.7. Conclusions
> 3.7.1. We conclude that the site selection for the hospital was properly considered at the time of the Acute Hospitals Review when it completed in 2001, taking public health matters into account. Site management of waste water facilities adjacent to the site complies with regulatory requirements and the site appears well maintained on direct inspection; no new knowledge or information has come to light that challenges the assumptions and assurances on which the decision was founded; public concern has been expressed to us as part of this Review but generally recorded nuisance and relevant data remain at a low level, and not appreciably different to other areas in the city on routine monitoring".

3.3 Consideration of a public-private partnership procurement model

When seeking to procure an infrastructure asset (such as a hospital), the Scottish Government would generally invite private sector contractors to tender to deliver the asset. There were, broadly speaking, two procurement models the Government could adopt.

One model was a standard procurement structure, in which the Government specified its requirements and paid a contractor to design and/or build it. On completion, the Government then took ownership of the asset, including the obligation to maintain it. NEC3 and NEC4 contracts have become public sector contracts of choice in the UK for this structure.

[57] A35289377 - NHS GGC Outline Business Case (public version) - February 2008, at p.12 and 13.
[58] A35289377 - NHS GGC Outline Business Case (public version) - February 2008, at p.13.
[59] Queen Elizabeth University Hospital Independent Review Report - June 2020.

As sub-categories to the standard procurement structure, the Government could follow the “traditional procurement” route, where the employer put its own design out to tender and retains the design risk through the construction process. Alternatively, the Government could select a so-called “Design and Build” procurement route. In a Design and Build contract, generally the employer sets out its requirements and the contractor submits a design for all or part of the works. After accepting a tender bid, the design may then also go through a design review process by the employer’s design team. In a Design and Build contract, the design risk is generally on the contractor, although the allocation of risk depends on the form of contract and any bespoke amendments.

The other model was a public private partnership structure. A public-private partnership is a cooperative arrangement between government and private sector to work together to deliver a project and/or to provide services to the population. Typically, the Government would contract out the design, build and maintenance/operation of a public facility to a private project delivery company, usually for a period of 25 to 30 years. The private company will be funded by some equity finance which will be substantially augmented by debt finance. During the 25 to 30 year period (commonly referred to as the “concession period”), the Government would pay back all project costs (possibly by allowing the service provider to retain the resulting revenue). Public-private partnership contracts are typically structured on the basis that the contractor assumes liability for the design.

A key benefit in the above mentioned structure is that most of the up-front finance is provided by the private sector, enabling the Government to increase national infrastructure investment without increasing public debt. However, the maintenance costs under this structure are generally higher than under the standard procurement routes.

Initially, in 2005, NHS Greater Glasgow explored the option of a Public-Private Partnership contract model to deliver the QEUH/RHC.

On that approach, the intention was for NHS Greater Glasgow to appoint a Technical Advisor to prepare a Public Sector Comparator design setting out the key design requirements and to prepare the outline business case (“OBC”). Once the OBC was approved, NHS Greater Glasgow would invite three potential delivery partners to develop a proposal to design, finance, build, and maintain the hospital for 25-years during which NHS Greater Glasgow would pay back all project costs.

3.4 Appointment of a Technical Advisor

Following a procurement process via the Official Journal of the European Union (“OJEU”) in 2005, NHS Greater Glasgow appointed Davis Langdon LLP as the project Technical Advisor in contemplation of adopting a public-private partnership procurement structure for delivery of the QEUH/RHC.

Davis Langdon LLP subconsulted several aspects of the works to others to form a larger Technical Advisor design team. The roles within that design team were: Davis Langdon LLP as the lead consultant (including project managers, costs consultants, health and safety and planning supervisor); Avanti Architects as architectural consultants; Directors Consultancy as health planners; SKM Anthony Hunts as civil and structural engineers; and Max Fordham LLP as mechanical and electrical engineers.[60]

3.5 Formation of NHS GGC

In April 2006, NHS Greater Glasgow amalgamated with part of NHS Argyll and Clyde to form NHS Greater Glasgow & Clyde ("NHS GGC"). The Inquiry understands that this did not affect the procurement strategy of the QEUH/RHC.

3.6 Scottish Executive Policy on Design Quality for NHS Scotland

In October 2006, the Scottish Executive issued "A Policy on Design Quality for NHS Scotland"[61]. It required Boards to produce a Design Action Plan in recognition that good design in healthcare buildings makes a measurable difference to the experience of staff, visitors and patients. It stated in the covering letter[62] that

> "4. The fundamental principle upon which this new policy is founded is that all NHS Scotland Bodies, as an integral part of the commitment to deliver the highest quality of environment for patient care, ensure that design quality is fully integrated into the healthcare building procurement process and is apportioned appropriate emphasis throughout all stages of this process.
>
> It also stated in the Policy (Annex A)[63] "Of particular importance in the context of healthcare buildings is the need for the Project Brief to incorporate policy, guidance and best practice in relation to reducing Healthcare Associated Infections (HAI). Guidance to ensure that prevention and control of infection issues are identified, analysed and planned for at the earliest stage of the provision of new or refurbished healthcare facilities Is contained within Scottish Health Facilities Note 30 (SHFN 30): 'Infection Control in the Built Environment: Design and Planning', published by Health Facilities Scotland. Additionally, Health facilities Scotland has developed a system which aims to assess and manage the risk of infection in the built healthcare environment called HAI-SCRIBE, an acronym for Healthcare Associated Infection System for Controlling Risk in the Built Environment. HAI-SCRIBE has been designed as an effective tool for the identification and assessment of potential

[60] The Inquiry does not hold copies of these appointments.
[61] A33010662 - Scottish Executive Policy on Design Quality for NHS Scotland - 23 October 2006.
[62] A33010662 - Scottish Executive Policy on Design Quality for NHS Scotland - 23 October 2006, at p.2.
[63] A33010662 - Scottish Executive Policy on Design Quality for NHS Scotland - 23 October 2006, at p.19.

hazards in the built environment and the management of these risks. The tool should be applied from the design and planning stages of a project through to the occupation and operation of the facility".

2007

3.7 Planning Application

In April 2007, a planning application was submitted to the local authority under the Town and Country Planning (Scotland) Act 1997[64]. The Inquiry understands that the local authority granted conditional approval of the plan in January 2008, subject to 43 conditions. 23 conditions were pre-start conditions.

3.8 Change of Government in Scotland

In May 2007, there was a change of Scottish Government. Before May 2007, there was a Labour/Liberal Democrat coalition. From 2007 to 2011 there was an SNP minority administration. The Inquiry is not aware that this affected the procurement strategy of the QEUH/RHC.

3.9 Design Solutions Report/PSC

A Public Sector Comparator (PSC) was developed to allow the clinical criteria and footprint allowance to be tested and a budget cost established. The PSC was captured within a Design Solutions Report by Davis Langdon LLP dated July 2007 [65]. This included design analysis and proposals as well as architectural drawings and Mechanical and Electrical drawings. Air quality is addressed at paragraph 5.6.6 "Air Quality":

Shieldhall Waste Water Treatment Works

"The works are situated approximately 400 meters from the proposed development (see Figure 28). The works are the largest Waste Water Treatment Works in Scotland, serving 800,000 people (this is very large). Conversation with Scottish Water have revealed that there are issues with five storm tanks each of which hold 1,000,000 gallons of storm water. In adverse weather, all water and raw sewage is diverted here. It then needs to be processed but the tanks are too large for odour to be contained and a lot of odour is created and released. This generates a large volume of complaints, especially in the summer. They have attempted to empty the tanks at night but are often compelled to empty them more frequently to allow for more storm water.

All normal sewage inlet channels are covered but money for more comprehensive odour control such as containment of the storm water tanks

[64] The Inquiry does not hold a copy of this document.
[65] A48943284 - Design Solutions Report - 2007.

requires significant capital investment. There are plans to upscale a project injecting an enzyme into the sludge which is claimed to dramatically reduce odour. Scottish Water is looking at options for containment on the site or even relocation but there is no certainty with respect to either scope or program for this at present.

HAI-SCRIBE (Healthcare Associated Infection System for Controlling Risk In the Built Environment):

Odour does not present a direct infection risk, but may force windows and ventilation intakes closed, and this in turn may increase the risk of HAI in the healthcare facility. Clinical areas require good rates of ventilation to provide dilution of pathogens generated within the hospital and to control odours within the hospital.

Odour is unpleasant to patients and visitors. Staff are more likely to become tolerant to the smell as they are continuously exposed to it.

The improvement of air quality in healthcare settings is a constituent of modern airborne hygiene procedures. The vast majority of microbes are associated with particles and air filtration is a solution to preventing spread of infection. The air quality requirements in healthcare settings vary from department to department and, often, even from room to room. Some areas require high-efficiency filtration of airborne micro-organisms to protect patients, staff and visitors (e.g. in operation suites, ICUs, TB isolation rooms), whereas other areas require the filtration of gaseous contaminants, chemicals and odours to provide a safer and more pleasant working environment (e.g. in laboratories, autopsy rooms, dental surgeries and pharmacies). It is thus essential that only very-high-quality filters are installed in these environments.

Increasingly stringent national and European environmental legislation on air quality has resulted in the development of new filters to remove and reduce odours and chemical fumes from the workplace. These filters combine a blend of high-grade carbon and alumina/ potassium permanganate that destroys odours, corrosive gases and fumes such as ammonia, arsine, ethylene, formaldehyde, hydrogen sulphide, nitrogen dioxide and oxide and sulphur dioxide as well as contaminants normally treated with standard carbon products. These Air Processors run with near-silent fans, are odour-free in operation and create a healthy and productive environment for everyone's benefit.

An odour problem will be present at times on the proposed site of the New South Glasgow caused by the waste water treatment works at Shieldhall. Odour is best treated at source and measures to control odour at this site could well be implemented by the Scottish Government and Water Authority. **If odour control at the hospital is deemed necessary, activated carbon filtration is the most suitable technology both in terms of effectiveness and cost. However, it would rely on a sealed**

building with a mechanical ventilation system throughout any odour treated areas."

Paragraph 6.3.9 "Ventilation" is also noted, in particular the conclusion that "The Clinical Areas, Wards and the remainder of the main hospital buildings are to be mechanically ventilated throughout" and the repeated references in this part of the Report to the importance of ventilation in controlling airborne infection.

The PSC design was revised and updated in 2008/9 by Currie & Brown so that it could be used as the design exemplar and form part of the Employer's Requirements documentation.

3.10 NHS GGC Design Action Plan

In October 2007, NHS GGC produced their Design Action Plan[66]. This is the plan required by the Policy on Design Quality referred to above. It set out the Board's vision for achieving design quality.

2008

3.11 Gateway Review 1

The New South Glasgow Hospitals project was subject to an Office of Government and Commerce (OGC) Gateway Review. The review was an independent assessment confirming that the business case was robust to meet the business need, was affordable, achievable with appropriate options explored and likely to achieve value for money.

In January 2008, 'Gateway Review Stage 1: Business Justification was completed. The project could then proceed to the Board and Scottish Capital Investment Group with the Outline Business Case subject to recommendations that had to be addressed before the Gateway 2 Review.

The outcome of the Gateway Review Stage 1 is summarised in paragraph 20.2 of the Outline Business Case (OBC) [67] referred to below. It records that five amber recommendations were made in the Gateway Review including "…The project team should take appropriate time to consider the full implications of a decision to adopt a traditional (design and build) procurement route…" and "…the project team, should review their draft plans for the project governance and management of the next phase.". The OBC records that immediate plans included:

- "A workshop organised for mid February 2008 attended by the Boards legal and financial advisers supported by a number of technical advisers to determine the optimum conventional procurement model.

[66] A35185698 - Design Action Plan - October 2007.
[67] A35289377 - NHS GGC Outline Business Case (public version) - February 2008, at p.142 to 144.
[67] A35289470 - NHS GCC Outline Business Case Appendices (public version) - February 2008.

- More detailed information and communication with staff side representations including continuing with internal meetings between the project managers and staff side, input into the Project Groups and involvement in how information should be more widely communicated to staff.

- Development of a fully consolidated risk register. This will amalgamate the current risk register held by the Project Team, the project risk management strategy (as detailed in Appendix 13) and the technical risk register developed by the technical advisers which focuses specifically on building risks.

- The governance structures for the next phase of the project are being developed with draft proposals reflected in this document which will be subject to revision in line with the preferred Design and Build procurement model which will be identified through an option appraisal at the mid February workshop."

3.12 Alternative procurement routes considered

Around February 2008, NHS GGC began investigating procurement routes that could be funded using public capital. On 19 February 2008, a Procurement Workshop[68] was held where a range of procurement options were considered. The initial review of the procurement model involved assessing alternative delivery models against critical success factors, and an Options Appraisal.

From March 2008, Ernst & Young undertook a 'market sounding' exercise and produced a report in September 2008. The conclusion is later recorded as "a two-stage Design and Build process with rapid selection to a single preferred bidder at stage one using the competitive dialogue procedure. At stage two, the preferred bidder develops the detailed design in conjunction with the Board" [69].

It is unclear when the decision to select the NEC3 Engineering & Construction with Option C Target with Activity Schedule as the form of contract (as opposed to a different standard form Design and Build contract) was formalised.

It is unclear whether NHS GGC sought or received advice from their legal advisors regarding the appropriateness of a Design and Build model or the choice of Target Cost.

[68] A35068196 - Email chain - P Moir and G Roy - Procurement Workshop 19 February 2008 - Attached briefing documents (agenda, evaluation form, list of procurement options, NSGH current position procurement) - 15 to 19 February 2008.
[69] A35422662 - NHS GGC Performance Review Group - Report on Procurement Strategy - 16 September 2008 (The Inquiry does not hold a copy of the Ernst & Young report. However, a summary of its conclusions is recorded in this document dated 16 September 2008).

3.13 Outline Business Case Approval

In April 2008, after having progressed through the Scottish Capital Investment Manual ("SCIM") process, the Outline Business Case ("OBC") was approved by the Scottish Government. The OBC was submitted on the basis that the project would be delivered using public capital funding.

The OBC[70] (and appendices[71]) is a key document in the chronology of events.

The OBC included the history of the "jewel in the crown of NHS Scotland"[72] from the 2002 Acute Services Review to date (section 1); the case for change and project objectives (Sections 4 and 5); the site and design configuration options (section 6); risk management strategy (section8), financial appraisal (section 9); the procurement model for scheme (section 10); and the project management arrangements including the role of advisors (sections 15-20).

3.14 Appointment of a Lead Consultant

In 2008, a re-scoped Lead Consultant role was developed for the design and build model. This would replace the Technical Advisor role used under the public private partnership model.

On 26 June 2008, an invitation to tender[73] was issued by an OJEU tender selection process.

On 6 August 2008, Currie & Brown responded to the tender invitation by tender submission[74], followed by a letter dated 13 August 2008[75] clarifying that tender submission.

By letter of 2 September 2008[76], NHS GGC wrote to Currie & Brown UK Ltd, accepting their tender bid. Currie & Brown then began performing the Lead Consultant role.

By an exchange of letters dated 18 January 2010 and 26 February 2010[77] the scope of Currie & Brown's appointment was restricted. See paragraph 3.26 of this PPP for further details.

[70] A35289377 - NHS GGC Outline Business Case (public version) - February 2008.
[71] A35289470 - NHS GCC Outline Business Case Appendices (public version) - February 2008.
[72] A35289470 - NHS GCC Outline Business Case Appendices (public version) - February 2008, at p.9.
[73] A32371754 - Invitation to Tender: "Appointment for a lead consultant and technical team for a public finance procurement route" - 26 June 2008.
[74] A32371144 - Letter from Currie & Brown to NHS GGC - 06 August 2008.
[75] The Inquiry does not hold a copy of this letter.
[76] A32372008 - Letter from NHS GGC to Currie & Brown - 02 September 2008.
[77] A32421344 - Letter from Currie & Brown to NHS GGC - 26 February 2010.

Whilst a formal memorandum of agreement between Greater Glasgow Health Board was not entered into between Greater Glasgow Health Board and Currie & Brown until 6 April 2011[78] (the "Currie & Brown Appointment"), clause 1.1 of Appendix A under that appointment said that the appointment commenced from the date that Currie & Brown started carrying out its duties.

The Currie & Brown appointment consisted of a short four-clause main agreement and an appendix in seven parts. Clause 1.2 of the main agreement set out that the agreement consisted of the memorandum of agreement and appendixes A to G.

Currie & Brown's appointment as set out in the appendix included the following terms:

"**APPENDIX PART A – CONDITIONS OF APPOINTMENT**

[…]

Generally

Note, where reference is made to the 'Consultant' throughout this section, this refers to the Lead Consultant and the Technical Advisory Team as a whole.

1.1 Duration of commission

The appointment of the Consultant will commence from the date that the Consultant commenced carrying out the Duties and the commission, unless suspended or terminated, shall be deemed to be completed on the conclusion of the duties by Work Stage, as set out in Part C of the Appendix.

Note this will be a staged appointment, the Board reserves the right to terminate the commission at the end of each and every Work Stage from 1A - 5. Progression from one Work Stage to another will be subject to written confirmation by the Board (which may be via the Project Director).

Objectives and obligations of the Consultant

1.2 Scope of Duties

The duties to be performed by the Consultant are those listed at Part C of the Appendix, as amplified by the Consultants' Bid Submission, (provided always that where there is a conflict between the duties listed at Part C of the Appendix and deliverables and methodologies contained within the Consultants' Bid Submission that the duties listed at Part C of the Appendix shall prevail) and any Additional Duties.

[…]

1.6 Duty of care

[78] A32421614 - Memorandum of Agreement between Greater Glasgow Health Board and Currie & Brown UK Limited - 06 April 2011.

The Consultant is to **exercise reasonable skill, care and diligence in the discharge of the Duties**. Submission of drawings, calculations, specification and other documentation produced by the Consultant for comment by the Board shall not relieve the Consultant of this responsibility.

[…]

1.29 Sub-contracting

The Lead Consultant shall not sub-contract any of the Duties without the written consent of the Board. **The Lead Consultant shall be fully responsible and liable for the performance of the Duties by any SubConsultant notwithstanding that the consent of the Board has been obtained**.

[…]

Notwithstanding the foregoing the Lead Consultant shall not require to obtain consent from the Board in respect of the appointment of the following Sub-Consultants and organisations forming part of the Technical Advisory Team or delivering services to the Technical Advisory Team:

- HLM Architects - architect for the adult and children's hospital (sub-contracting to BMJ Architects - architect for the laboratory block and all projects; Hirst Landscape Architects - landscape architect; and Buro Happold - fire engineers);
- Buchan Associates - healthcare planning for all projects;
- URS - civil and structural engineer for all projects; and
- Wallace Whittle - building services for the adult and children's hospital and laboratory (subcontracting to Harley Haddow - building services for the adult and children's hospital).

[…]

APPENDIX B – SCHEME PARTICULARS

[…]

1.2 General description

The Duties are required to assist the Board to develop a full brief, tender and all Employer's Requirements documentation to enable engagement in a public finance procurement for the New South Glasgow Hospital Project, to provide the hospital facilities as listed below. The Duties include the management of the Building Contract with a D&B consortia, through to the successful completion of the works, commissioning and equipping, transfer and occupation.

Key elements of the project are (for information):

- Development of an integrated adult acute and children's hospital proving the full range of acute health services.
- Development of a new Laboratory facility including Mortuary and Post-Mortem Services, Biochemistry, Haematology and Blood Transfusion.

- Provision of a rooftop helipad.
- Possible provision of non-clinical services such as Hard FM services to the new facilities by the D&B contractor for an initial 3-5 year period.
- The supply and installation of Group 1 equipment and location and/or fitting of Group 2 equipment supplied by the Board.
- Information Management and Technology (IM&T)- Out with this project, the Board is procuring software and end-use hardware as part of a separate IM&T project.

The Board requires the provision of integrated facilities that are readily adaptable to changing clinical practice and makes the best use of new technologies.

[…]

1.12 Lead Consultant Team

It is the **Board's intention to appoint the following disciplines as part of the Lead Consultant team**. The team will be lead by the Lead Consultant/Project Manager; **a single appointment will be made with this company for the whole team**. […].

- Lead Consultant/ Project Management
- Employer's Agent role (construction stage)/Contract Administration
- Architectural Design and Site Masterplanning
- Healthcare Planning
- Civil and Structural Engineering
- Building Services Engineering & IT Infrastructure
- Cost Consultant/Quantity Surveying/Lifecycle costing
- CDM Co-ordinator
- Risk and Value Management advice
- Facilities Management advice (soft and hard FM)
- Procurement and Construction Management Advice
- Landscape Architect

[…]

The Board has existing Consultancy agreements for the supply the following services, these appointments have been made and do not form part of this commission. The Lead Consultant team will be expected to work with these advisers, and acceptance of the commission will be conditional on this.

- Legal - Shepherd & Wedderburn LLP.
- Financial - Ernst & Young LLP.
- Town Planning Consultant- Keppie Planning.
- Environmental Consultant- Ironside Farrar.
- Transportation Consultant - JMP Consultants Ltd.
- The Carbon Trust and sub-consultant.

[…]

1.14 Site Inspection Staff

It is the Board's intention to make direct appointments for the under-noted roles, some will be made for the duration of the works

contract others for particular stages, the appointments will be full-time. The Lead Consultant team will be required to structure and manage the selection and appointment process for all site inspection staff on behalf of the Board, although the contractual and payment arrangements will be between the Board and the respective companies.

- **Building Clerk of Works (4)**
- **M&E Clerk of Works (3)**
- **Site Engineer (2)** - sub-structure, drainage, groundworks and frame.

The Lead Consultant will manage and direct the work of the site inspectorate staff. Site Inspectorate staff will be based on site for the duration of the works contract.

[…]

1.16 Board's procedures/ requirements

• NHS GG&C PSC / OBC documentation and OBC Stage Design Report as prepared by others, including all associated drawings, specifications and Project costs.
• Scottish Capital Investment Manual (SCIM).
• SEHD - Procode V 2.0
• The Board's Design Action Plan
• Health Facilities Scotland - SHPN and/or NHS HBN and HTM's.
• NHS Estates and others guidance documents such as AEDET, NHS NEAT, or BREEAM.
• Government Gateway reviews will be undertaken at various stages (see separate section).
• OGC Guidance on Competitive Dialogue and general project delivery. (use of CD unlikely).
• FBC

1.17 OGC Gateway Reviews

The Scheme will be subject to external review by a Gateway Review Panel at various stages of the Scheme and the Lead Consultant team will be expected to assist the Board's Project Team at the following stages;

Gateway Review 0 - Strategy assessment (2 reviews).
Gateway Review 2 - Procurement strategy.
Gateway Review 3 - Investment Decision.
Gateway Review 4 - Readiness for Service.
Gateway Review 5 - Benefits Realisation.

Input from the Lead Consultant will be focused to technical elements associated with each review, and cover matters such as programme, cost management, procurement strategy and structure, project specification and buildability. Each Gateway Review will last approximately 2- 3 days and it is likely that the Lead Consultant will need to prepare a status report on technical elements and be available for interview for 2-3 hours.

[…]

1.21 Further Development of the Board's OBC/PSC Design Exemplar

The Board have developed a PSC design exemplar through the first stage of a PPP procurement strategy. While this strategy has now changed course towards a public finance route, a good deal of the design and information prepared for OBC is still valid. […]

The PSC design therefore requires to be revised and updated before it can be used as the design exemplar and form part of the Employers Requirements documentation

[…]

APPENDIC PART C – CONSULTANTS' DUTIES

Lead Consultant Technical Advisory Team - Scope Of Services

The Lead Consultant/ Technical Advisory Team will provide guidance, advice and active input to the Board in the following key areas throughout the duration of the commission, the Lead Consultant team will be expected to manage and direct the process on behalf of the Board. The Team will be responsible for the
procurement of;

- The New Adult and Children's Hospital Project - two stage D&B process.
- The New Laboratory Project- single stage D&B process.

The Board require the following consultancy services as a minimum;

- Lead Consultant/ Project Manager
- Employer's Agent role (construction stage)/Contract Administration
- Architectural Design and Site Masterplanning
- Healthcare Planning
- Civil and Structural Engineering
- Building Services Engineering & IT Infrastructure
- Cost Consultant Quantity Surveying/Lifecycle costing
- CDM Co-ordinator
- Procurement and Construction Management advice.
- Landscape Architect.
- Risk and Value Management advice
- Facilities Management advice (soft and hard FM)

[…]

General Duties of the Team

[…]

- Remain up to date and responsive to changes in legislation or guidance on all matters relative to the project. […]
- **Advise the Board on general issues of on-going advice on government policy; compliance with SCIM, SEHD, DoH, OGC and Treasury procedures; compliance with Local Council planning procedures. Compliance with legislation and NHS Design Guidance.**

Key Team Activities and Tasks for Stage 1A - Preparation of Employers Requirements Documentation

[…]

1) Manage the compilation and publication of a comprehensive set of Employers Requirements documents for the approval of the Project Director. The contents should include as a minimum the items list below, and the bulk of the work will be undertaken by your team.
    - Board's ASR Strategy and clinical strategy.

[…]

2) Develop and manage a process through OJEU to advertise the project (in association with the Board's legal adviser), and then to evaluate and shortlist interested D&B consortia, to include preparation of a PQQ and information Memorandum. Provide advice and guidance to the Board on all aspects of this process including timetable. The Board hope to engage a maximum of 3 D&B teams in this process. Assist the Board's Project Team with responses to request for further information during pre-qualification process.

[…]

Key Team Activities and Tasks for Stage 1 B - Stage One Design and Bid Development and Evaluation, selection of a preferred bidder D&B team.

1) Produce, print, package and issue Employer's Requirements tender documentation to selected D&B consortia - max 3. During this stage further develop any tender documentation and information for this or next stage that maybe outstanding. Note much of this information will be developed in conjunction with the Board's Project Team and user groups and ongoing development and detail of the project requirements.

[…]

6) Manage the receipt of Stage 1 bids from three D&B Consortia, and commence and manage the full process to evaluate the bids with full involvement of the Board's Project Team and the eventual involvement of user groups perhaps by way of open day presentations by each D&B bid team.
7) On completion of the evaluation of bids, prepare a full report giving the Project Director a recommendation based on (exact criteria will be confirmed later) value for money, design solution / functionality, healthcare design and technical specifications and systems and all financial and commercial aspects. The report should also include any significant areas of deviation from the Employer's Requirements and compliance statement and detailed 'technical' and 'user' evaluations.

Key Team Activities and Tasks for Stage 2 - Stage 2 Design and Bid Development, package tender through to agreement of a Guaranteed Maximum Price, Full Business Case preparation and approval and contract sign off.

1) Complete and issue any further information in respect of the Employers Requirements.
2) Engage with preferred bidder and develop and agree a structured programme to allow the design and work packages to be fully developed

for tender issue.

[…]

5) Support the Board in the 'user' evaluation of the design proposals as they develop, by developing approaches to enable users to fully understand the design, technical and clinical operational issues implicit in the preferred bidders design proposals.

[…]

7) Participate in review and evaluation of all aspects of Stage 2 bid response, provide clarification as required on all design and technical matters. Prepare technical report on Stage 2 bid submission, including evaluation process and giving recommendation to the Project Director and Executive Board. The report should also include any significant areas of deviation from the output specification and compliance statement and detailed 'technical' and 'user' evaluations.

8) Based on the format/content for Stage 2 tender response, developed by your team and included for information in the Stage 1 tender documents, secure a full Stage 2 tender submission from the D&B consortia. While the detail of this package will be complex we reproduce below a minimum requirement to assist you to prepare your bid. The bulk of this evaluation will be undertaken by your team, and the output included in a formal report to the Project Director.

Content

- By end of stage - full clinical sign off;
- Agreed functional content.

9) **Undertake and manage a full technical, financial and commercial review of the preferred bidders final tender submission, provide clarification as required on all technical matters, prepare a full report giving the Project Director a recommendation for approval or otherwise. The report should also include any significant areas of deviation from the Employer's Requirements and detailed 'technical' and 'user' evaluations.** Await approval from Project Director to proceed to next stage.

Key Team Activities and Tasks for Stage 3 - Implementation and Construction, Design Development.

[…]

2) Undertake the role of Employers Agent for the duration of the works contract and manage the interface between the Board and the D&B contractor.

Key Activities and Tasks for Stage 4 - Equipping and Operational Commissioning

2) **Assist the Project Director to develop a fully structured Commissioning Plan** for the operational commissioning and equipping of the following projects in chronological order;
   - New Laboratory Project
   - New Children's Hospital
   - New Adult Acute Hospital

LEAD CONSULTANT / PROJECT MANAGER – KEY ROLE AND

RESPONSIBILITIES

Key aspects of Project Manager's role:-

[…]

- Manage the technical review of D&B bidder proposals during the procurement process for Stage 1 and Stage 2 final bid at Contract Close.

[…]

- Carry out and deliver the duties of Employers Agent throughout the construction phase, manage interface with D&B contractor, manage and administer contract and associated processes.

[…]

- Provide full shadow design team service throughout the duration of the works contract.

ARCHITECT / SITE MASTERPLANNER – KEY ROLE AND RESPONSIBILITIES

- Take lead on all matters relative to architectural, building and site master planning, interior design, room layouts, fire engineering, fire escape and fire safety, fabric, components and their life-cycle, phasing and construction.

[…]

- Assist with preparation of Employer's Requirements documentation, the bid process and evaluation at all stages.

[…]

- Review bidders proposals at all stages for compliance with Employer's Requirements document, participate in the production of technical reports at the end of each stage, to include aspects on architectural, building construction, healthcare design, interior design, landscape and master planning.
- Provide full shadow design team architectural and building service throughout the duration of the works contract.
- In conjunction with Board, manage activities of Board appointed Clerks of Works during construction phase.
- Provide monthly reports on compliance of project with Employer's Requirements.

[…]

HEALTHCARE PLANNER – KEY ROLE AND RESPONSIBILITIES

Key aspects of Healthcare Planners are:-

- Take lead on all matters relative to clinical design, clinical output specifications, operational policies, functional content, schedules of accommodation, within Technical Advisory Team
- Lead on behalf of the TA team and assist the Project Managers for the Adult and Children's Hospitals with the development of Clinical Output Spees / Operational Policies for all departments within the new facilities, working closely with NHS staff to agree and sign off a standard reference document for the Employer's Requirements briefing process and documents. In other words ensure full briefing packs are prepared for all departments to a suitable level for the project.
- Actively participate in design development process between user groups

and bidder design teams through the various stages of tender through to contract close.
- Lead in clinical and healthcare planning design reviews from bidders and evaluation meetings at each stage of the process.
- **Review bidders proposals at all stages for compliance with Employer's Requirements**, participate in the production of technical reports at the end of each stage, to include aspects on healthcare planning and design, good practice, compliance with National healthcare quality, **infection control and design standards.**
- Provide full shadow design team 'due diligence' service on healthcare planning and design matters throughout the duration of the works contract.

BUILDING SERVICES ENGINEER – KEY ROLE AND RESPONSIBILIIES
Key aspects of Services Engineer's role:-
- **Take lead on all matters relative to mechanical and electrical engineering services,** energy and environmental matters, renewables, carbon neutral design, integration with existing hospital and other main utility services.

[…]
- **Assist with the Design Development process** and input to the ADB room data and room layout processes by the supply of building engineering information for the sheets to focus on environmental conditions, **air changes**, room temperatures, humidity any **specialist filtration, negative or positive pressure systems**. Also review and advise on M&E equipment, including the location of M&E apparatus such as light and power switches, light fitments, air handling grillage, appropriate types of heating systems, powered medical equipment, telecoms and IT.
- **Review bidders proposals at all stages for compliance with tender requirements**, participate in the production of technical reports at the end of each stage, to include aspects on building services.
- Provide full shadow design team service throughout the duration of the works contract.
- **Fully participate in the technical commissioning** of the new facilities in conjunction with Board estates staff and the contractor.

COST CONSULTANT/ QUANTITY SURVEYOR- KEY ROLE AND RESPONSIBILITIES
[…]

CIVIL AND STRUCTURAL ENGINEER- KEY ROLE AND RESPONSIBILITIES
[…]

FACILITIES MANAGEMENT DESIGN ADVICE- KEY ROLE AND RESPONSIBILITIES
[…]

CDM CO-ORDINATOR- KEY ROLE AND RESPONSIBILITIES
[…]

LANDSCAPE ARCHITECT
[…]"

3.15 Appointment of Sub Consultants including Wallace Whittle

After Currie & Brown were appointed as lead consultant, they appointed various sub consultants. These included:

- HLM Architects - architect advisor;
- Wallace Whittle - building Services engineer (including M&E services);
- Buchanan Associates - healthcare planning; and
- URS Corporation - civil and structural engineering and CDM coordinator.

In the context of PPP 11(water) and PPP 12 (ventilation), the role of Wallace Whittle as the provider of mechanical and electrical (commonly known as "M&E") services is of particular relevance. The terms of their engagement are therefore produced and referred to below.

The Inquiry has been advised that Wallace Whittle was acquired by TUV SUD in July 2011 and then, in April 2021 subject to a management buyout whereby it was reestablished under the Wallace Whittle name.

The Agreement between Currie & Brown and Wallace Whittle is dated 31 May 2012[79] but, like Currie & Brown, their services had been delivered from a much earlier date which is believed by the Inquiry to be 2008.

In relation to Wallace Whittle's involvement with the project, there is an additional feature which should be noted. Wallace Whittle was involved in the project in two separate ways at two separate times. They were initially appointed by Currie & Brown as subconsultants advising NHS GGC. They were subsequently appointed by Brookfield/Multiplex as subconsultants advising them. The Inquiry has been advised by the legal advisors of Wallace Whittle/TUV SUD that:

- Wallace Whittle's appointment by Currie & Brown ceased at conclusion of the tender exercise by December 2009;

- neither Wallace Whittle nor TUV SUD was part of Multiplex's design team. Neither was it involved with assessing Multiplex's developed design on behalf of the health board (a role carried out by Capita). It was not envisaged that Wallace Whittle would have any ongoing role and their involvement with the Project ceased at this point;

- Wallace Whittle may have provided some ad-hoc advice to Currie & Brown on specific technical issues (on a 'time charge' basis) after the completion of the

[79] A32659704 - Memorandum of Agreement between Currie & Brown UK Limited and Wallace Whittle Limited - 31 May 2012.

tender process; however, this was with respect to the electrical infrastructure/district of the larger campus, rather than being connected with the construction of the hospital itself;

- the mechanical and electrical engineer appointed by Multiplex was Zisman Bowyer & Partners LLP ("ZBP"). On 28 January 2013 ZBP entered administration. On 7 March 2013 Multiplex appointed TUV SUD to take over and complete ZBP's role;

- TUV SUD acquired a number of assets from ZPB (including staff) but was appointed under a distinct agreement with Multiplex i.e. TUV SUD did not take over ZBP's existing appointment as a 'going concern' but was separately appointed in its own right;

  [Note: the terms of the agreement, in the context of Wallace Whittle /TUV SUD "replacing" ZBP in 2013, are referred to later in this chronology]

- by the time TUV SUD were appointed the mechanical and electrical design was complete and the construction phase of the project was already underway;

- TUV SUD's role in the project was principally focused on closing out the project through the commissioning and inspection phases. These tasks were primarily undertaken by a specific team by Multiplex with Capita representing the health board. TUV SUD's role was to attend specific elements of this process as directed, by Multiplex, and respond to any ancillary queries raised; and

- separately, in early 2016 after the hospital was opened, TUV was involved with the redesign of wards 2A and 4B. This was carried out on the instruction of Multiplex and understood to be the result of a change in the client brief. This involved alterations to the ventilation of those wards.

2009

3.16 The Technical Advisory Team

From around the end of 2008 through to April 2009, the Technical Advisory Team led by Currie & Brown prepared the exemplar design, to inform the Employer's Requirements for use in the Building Contract.

The Technical Advisory Team also compiled the Employer's Requirements that were issued in May 2009.The Inquiry understands that, in particular, it was Wallace Whittle that was responsible for Appendix M (M&E) of the Employer's Requirements. See Part 2 of this PPP (The Building Contract) for further details about the content of Appendix M.

The Inquiry holds copies of minutes of meetings of the Technical Review Group in 2009[80] which show recurring items of discussion were (a) the importance of the

[80] A48705272 - Technical / ER's Meeting Minute - 30 January 2009.
A48705274 - Technical / ER's Meeting Minute - 13 February 2009.

Employer's Requirements; (b) the importance of compliance with SHTMs/HTMs; and (c) the impact of a "sealed/non sealed building". Attendees included Peter Moir (NHS GGC), David Hall and Mark Baird of Currie & Brown, representatives of HLM and Stewart McKechnie of Wallace Whittle.

There appears to have been an ongoing discussion about whether the building should be sealed or non sealed which was recorded in the minutes, usually as item 15. Wallace Whittle was actively involved in those discussions as one would expect of the M& E engineer. It appears that they were, at this stage, developing a mixed mode narrative for inclusion in Appendix M (Mechanical &Electrical) of the Employer's Requirements.

3.17 Gateway Review 2 (delivery strategy)

In January 2009, the Scottish Government carried out Gateway Review 2 (delivery strategy)[81].

3.18 Tender process

In February 2009, the project was advertised via the OJEU process[82]. The main contractor was to be selected using a tender process involving a competitive dialogue period managed by Currie & Brown.

Clause 7 of IPCD Volume 1 contained an outline timetable for the procurement as follows:

A48705273 - Technical / ER's Meeting Minute - 27 February 2009.
A48705275 - Technical / ER's Meeting Minute - 13 March 2009.
A48705276 - Technical / ER's Meeting - Summary of Board Actions - 19 March 2009.
[81] The Inquiry does not hold a copy of Gateway Review 2. However, it is referred to in the Full Business Case.
[82] The Inquiry does not hold a copy of OJEU advertisement. However, it is referred to in the Full Business Case.

Event	Milestone
Publication of OJEU (incl MoI and PQQ)	10 February 2009
Closing date for responses to PQQ	20 March 2009
Evaluation of PQQ responses and shortlisting of bidders	08 April 2009
Issue of Invitation to Participate in Competitive Dialogue (ITPD) to bidders	01 May 2009
Tender Return	11 September 2009
Evaluation of Bids and Contract Award	November 2009
Stage 1 (Design + Construction of New Laboratories) commences	November 2009
Stage 2 (Detailed Design of Adult, Children's and Infrastructure to FBC Submission) commences	November 2009
Stage 2 completion, FBC and approval to proceed with Stage 3	November 2010
Stage 3 (Engagement to carry out the construction of the Adult, Children's and Infrastructure) commences	November 2010
Stage 1 Completion (Construction) - Laboratory Facilities	December 2011
Operational Date – Laboratory Facilities	February 2012
Stage 3 Completion (Construction) – Hospitals	January 2015
Operational Date – Hospitals	Summer 2015
Stage 3A (Demolition of Surgical Block and associated buildings, and completion of soft landscaping) commences	Summer 2015
Stage 3A completion	Summer 2016

Five potential bidders completed a pre-qualifying questionnaire, namely Balfour Beaty Group Limited, Brookfield Europe LP, FCC Elliot Healthcare Ltd, Laing O'Rourke Construction Limited, and Miller Construction UK Ltd.

In April 2009, Atkins Limited undertook a peer review of the Employer's Requirements and competitive dialogue process[83].

In May 2009, three bidders – namely Balfour Beatty Group Limited, Brookfield, and Laing O'Rourke Construction Limited – were selected from the pre-qualifying questionnaires. On 11 May 2009 they were issued with an Invitation to Participate in Competitive Dialogue ("IPCD") which included (in volume 2) the Employer's Requirements. See Part 2 (The Building Contract) of this PPP for more details of the IPCD.

3.19 Competitive dialogue period

Between June and August 2009, competitive dialogue meetings took place with the three bidders. They were identified as bidder A, B and C. 16 scheduled meetings were planned with each bidder to discuss and clarify NHS GGC's requirements for the main aspects of the project.

The competitive dialogue period was strictly controlled to ensure parity between bidders. Agendas were produced for meetings and outcomes noted. The meetings were categorised according to four workstreams; design/site; logistics; laboratories/FM; commercial.

The competitive dialogue period was an intensive period of time for NHS GGC, the three bidders, and their professional consultants.

[83] The Inquiry does not hold a copy of this document.

During this period, Requests for Information (RFIs) were made by bidders to NHS GCC in a prescribed form. An example RFI is produced to show the type of RFI that could be made by a bidder and how it was responded to. In this example RFI (number 38[84]), bidder A (not Brookfield) asks for clarification on AHU plant and distribution strategy. The bidder proposes common AHU plant rather than departmental dedicated plant as required by Appendix M&E 3 -2.4.2. NHS GGC's response is "Not acceptable. Please comply with M&E 3".

Brookfield submitted 147 RFIs which were later recorded in the RFI log incorporated into the Building Contract.

During this period, meetings with bidders were carefully structured with agendas, minutes of meetings and action lists for each bidder. The following selection of documents is produced to show the nature and detail of the issues being discussed in the meetings.

- A dialogue meeting agenda dated 27 May 2009[85]. In this document, ZBP (Multiplex's subconsultants) appear to be actively engaged in the agenda items related to M&E (as one would expect for an M&E specialist consultant).

- Action lists for Bidder B (Brookfield) in relation to the commercial dialogue sessions dated 5 June 2009[86] and 14 July 2009[87] It is noted that in the last entry of the document dated 5 June 2009 that, as at that date, the intention still appears to be that architects would be novated over to the successful contractors as would be expected in a standard design and build contract.

- In relation to the design dialogue sessions, the following documents are produced:

  - an action list for bidder B (Brookfield) dated 15 June 2009[88];

  - a design dialogue presentation for bidder B (Brookfield) dated 23 June 2009[89];

  - a design dialogue agenda for bidder B (Brookfield) dated 7 July 2009[90]; and

  - a design dialogue minute for bidder B (Brookfield) dated 7 July 2009[91].

[84] A48705350 - NSGH Bidder A RFI 038 - Response - 05 May 2009.
[85] A48705333 - NSGH Dialogue Meeting Agenda - Bidder B - 27 May 2009.
[86] A48705355 - NSGH Commercial Competitive Dialogue - Bidder B - Action List - 05 June 2009.
[87] A48705254 - NSHG Commercial Competitive Dialogue - Bidder B - Action List - 14 July 2009.
[88] A48705373 - NSGH Dialogue Meeting Agenda Minute - Bidder B - 15 June 2009.
[89] A48705396 - NSGH Design Dialogue Meeting 4 - Bidder B - Presentation - 23 June 2009.
[90] A48705401 - NSGH Dialogue Meeting Agenda - Bidder B - 07 July 2009.
[91] A48705407 - NSGH Dialogue Meeting Agenda Minute - Bidder B - 07 July 2009.

The competitive dialogue process concluded in August 2009. The three bidders submitted their tenders on or around 11 September 2009.

3.20 Clarifications to bidders

During the competitive dialogue period, clarifications were issued to the bidders in respect of the documents issued with the ITCD. The following clarifications are highlighted.

3.20.1 Isolation room clarification

A clarification was issued to bidders called “Update on Isolation Rooms”[92] indicating the isolation rooms required for the New Adult Hospital. The clarification refers to the haemato-oncology ward, respiratory wards, renal inpatient wards, A&E and “Critical Care (includes ICU/Surgical and Medical HDU”. It concludes: “All in accordance with SHPN4 and SHTM 03-01”.

3.20.2 Removal of maximum temperature variant

On or around 28 May 2009, a document called “NSGH Project Issue 01 Maximum temperature variant”[93] was produced by or for NHS GGC. The first page is reproduced since this clarification appears to be relied up on as a reason for the ZBP Ventilation Strategy Document produced in December 2009 (see paragraph 3.23.3 for further details).

> “**Maximum Temperature Variant**.
>
> The mandatory variant bid was partially removed from the ER’s and the references have been highlighted under separate cover.
>
> The Variant bid allowed the Board to take a decision on maximum temperature prior to contractor appointment based on fully costed schemes.
>
> This has been discussed at length with Currie and Brown, we believe that uncontrolled removal has increased the risk that the bidders will not provide an environmental scheme with sufficient flexibility to allow for future requirements and will increase pressure on bidders to provide lowest construction cost solutions.
>
> We have been advised that thermal comfort is still a high priority of the Board, late removal of the maximum temperature variant bid appears to

[92] A36372525 - Update on the isolation rooms for the New South Glasgow (adult) Hospital - undated but understood to be issued during the competitive dialogue period.
[93] A48705331 Removal of Mandatory Maximum Temperature Variant - Issue 01 - 28 May 2009.

have signaled some of the bidders to reduce the importance of avoidance of overheating.

We suggest that this issue is clarified and guidance given to avoid difficulties comparing unlike schemes and possible reduction in cost control created by amendments to the bidders proposals after Contractor appointment.

At this stage we suggest that the bidders are reminded of the importance of thermal comfort and the avoidance of over heating, this could be achieved by issuing a response in the Technical Query process in line with the attached or similar wording.

We recommend that this is circulated and considered by all parties with agreement reached prior to issue to the bidders."

The remainder of the document is the same as the document called "NSGACL Removal of Maximum Temperature Variant_iss1_rev." [94] which was issued to bidders on or around 8 June 2009. That document formed part of the Building Contract. It is therefore referred to in greater detail in paragraph 2.4.3 of this PPP.

3.20.3 Technical clarifications

After the submission of bids and before the selection of the preferred bidder, bid clarifications were issued to Brookfield.

- 23 September 2009 - "Bid submission clarifications, bidder:1 (Brookfield), Technical Clarification:1"[95]. On page 2 it noted: "Energy model - confirm that the energy model is fully compatible with the servicing strategies set out in volume 3 in particular the use of a sealed building with chilled beams." The response is not known.

- 30 September 2009 - "Bid Submission clarifications, bidder:1 (Brookfield), Technical Clarification:2"[96]. This included the clarifications recorded in a document called "Brookfield Information Requests[97]." prepared by Wallace Whittle which included: "1) Please indicate any deviations from M&E elements of the ER's …21) Please confirm that all services comply with HAI -SCRIBE…".

- 2 October 2009 - "Bid Submission clarifications, bidder:1 (Brookfield), Technical Clarification:3"[98]. This is produced for completeness although it is not directly relevant.

3.21 Brookfield/Multiplex design team

Brookfield had a design team assisting throughout the project. It included:

[94] A33010775 - Removal of Mandatory Maximum Temperature Variant - June 2009.
[95] A48705255 - Brookfield Technical Clarification 1 - 23 September 2009.
[96] A48705258 - Brookfield Technical Clarification 2 - 30 September 2009.
[97] A48705256 - Brookfield Information Requests for Clarification 2 - 25 September 2009.
[98] A48705260 - Brookfield Technical Clarification 3 - 02 October 2009.

3.21.1 Nightingale/IBI

Nightingale Associates Ltd were appointed by Brookfield as their Lead Consultant and Architect. Their formal Agreement is dated 18 June 2010[99]. Nightingale provided services before this date.

The Inquiry has been advised that Nightingale Associates was acquired by IBI in June 2010. Nightingale Associates designed the adult and children's hospitals of the QEUH/RHC. In particular, Nightingale Associates had responsibility for the coordination of the Room Data Sheets and were a key party in the RDD process.

The Inquiry has been advised by their legal advisors that:

- IBI's architectural design remit did not extend to the design of the mechanical, electrical and plumbing systems and they understand that (1) the ventilation and water systems were designed by TUV SUD (taking over the role from ZBP, the original MEP consultant); and (2) Mercury Engineering, the MEP subcontractor who also bore design responsibilities;
- IBI's role, as it related to ventilation, involved coordination of: (i) the location of ventilation-related components within each room (i.e. avoiding clashes between MEP components and other equipment in the room); and (ii) the receipt and input of environmental information onto a Room Data Sheet ("RDS") for each type of room at the QEUH; and
- IBI's role, as it related to water and drainage systems, was limited to the specification of materials in areas of sanitaryware e.g. the pipework in the boxes behind sink and WC units).

3.21.2 ZBP

Zisman Bowyer & Partners LLP ("ZBP") were appointed by Brookfield as mechanical, electrical and plumbing (MEP) services engineers. Their formal agreement is dated 28 September 2010[100]. ZBP provided services before this date. An administrator was appointed to ZBP in February 2013.

In March 2013, TUV SUD Ltd (trading as Wallace Whittle) entered into a formal agreement dated 7 March 2013[101] for services in connection with Stage 3 (Final Design of the New Hospitals Building) and Stage 3A (Demolition and Final Landscaping). The Services "include all services performed or to have been performed by Zisman Bowyer & Partners LLP ("ZBP") pursuant to the Professional

[99] A32893603 - Professional Services Contract between Brookfield Construction (UK) Limited and Nightingale Architects Limited - 18 June 2010.
[100] A32607385 - Professional Services Contract between Brookfield Construction (UK) Limited and Zisman Bowyer & Partners LLP - 28 September 2010.
[101] A32607363 - Professional Services Contract between Brookfield Multiplex Construction Europe Limited and TUV SUD Limited (trading as "Wallace Whittle") - 07 March 2013.

Services Contract entered into between the Employer and Zisman Bowyer & Partners LLP dated 28 September 2010 in respect of the Project ("ZBP Appointment')" (Clause 1).

Clause 4 states:

> **"The Consultant agrees to be responsible for and liable to the Employer pursuant to this contract for all of the duties, obligations and services provided or to have been provided by ZBP pursuant to the ZBP Appointment. The Consultant warrants to the Employer that all services performed by ZBP pursuant to the ZBP Appointment have been carried out in accordance with the requirements and standards required by the ZBP Appointment**. However, and notwithstanding any other provision of this contract, the Consultant shall bear no responsibility or liability for or in respect of delays arising to the Project as a consequence of ZBP's insolvency or the resulting termination of the ZBP Appointment" (bold added).

Schedule 1 Scope of Services is referred to. The Services are to be provided in the following work stages: Concept Design and design development; construction documentation and construction phase; commissioning, completion and post completion.

It is unknown whether NHS Greater Glasgow Health Board or Currie & Brown approved this appointment of Wallace Whittle by Brookfield.

3.21.3 WSP

WSP UK Ltd were appointed as Structural and Civil Engineer and other specialist Design Services by agreement dated 17 August 2010.

3.21.4 Doig & Smith

Doig & Smith Limited were appointed as quantity surveyors by agreement dated 15 November 2010.

Whilst the dates of the appointments referred to above post-date the bidding process, the Inquiry understands that at least some of those consultants were already providing services from an earlier date including during the competitive dialogue stage.

3.22 Preferred bidder selected

In October 2009, a five-week evaluation process was undertaken, in which NHS GGC and its advisers evaluated and scored the proposals. The bid evaluation used a Most Economically Advantageous Tender ("MEAT") scoring methodology to evaluate the tenders, based on design, logistics and commercial aspects.

On 3 November 2009, the Performance Review Group were asked to approve the appointment of preferred bidder 1 (i.e. Brookfield). The minutes of the meeting are produced.[102] A paper was submitted by the Director of Acute Services Strategy Implementation and Planning (Paper No 09/43)[103]. A PowerPoint presentation[104] was made by Mr Seabourne to the Performance Review Group. Its agenda included technical overview and evaluation, cost analysis, legal considerations, MEAT score, affordability and recommendations. In respect of Brookfield's masterplan, it is noted that it "Fully met the Board's Exemplar requirements" (page 10) and, in respect of "1/500's Departmental Adjacencies), (page 11) is "Compliant with Employer's Requirements". In respect of legal considerations, it is noted: "Clarification from bidders to ensure there is no misunderstanding". The recommendation is to appoint Brookfield. The next steps include "From 16 November 2009 engage with Brookfield regarding pre- contract requirements".

It was decided that Brookfield Europe LP would be appointed preferred contractor.

The period between Brookfield being appointed preferred bidder (early November 2009) and the Building Contract being signed (18 December 2009) was between four and six weeks. The Inquiry currently has an incomplete picture of the events during this period which led up to the Agreed Ventilation Derogation being included in the M&E Clarification Log which was part of the Building Contract. The Inquiry's current understanding of the position is noted in the following paragraphs.

3.23 Agreed Ventilation Derogation

After being appointed as the preferred bidder, Brookfield continued the dialogue with NHS GGC. The Inquiry's understanding of what happened will be developed through the evidence of witnesses in future hearings. In the meantime, it is noted that the Inquiry holds the following documents.

3.23.1 NSGH Contract Preparation - Design Summary

On 4 December 2009, D. Hall of Currie & Brown sent to R. Ballingall of Brookfield, (copied to others) an email[105] attaching an updated RFI Log with Board comments and a M&E Design Summary "which is not adding anything to the ER's, but rather identifying areas where clarity is required on the bid in relation to its compliance with the ER's".

The Design Summary records that the ward air change rate is currently shown in the drawings submitted by Brookfield as 2.5 A/HR which is not in compliance with SHTM 03-01.

[102] A34871046 - Performance Review Group Minutes - 03 November 2009.
[103] A35382437 - Performance Review Group Final Paper - 03 November 2009.
[104] A35561501 - Performance Review Group PowerPoint Presentation - 03 November 2009.
[105] A48746242 - Email from D Hall to R Ballingall and others - RFI Log and M&E Design Summary attachments - 04 December 2009.

3.23.2 Bid Submission Clarifications

On or around 15 December 2009, a second version of a table of Bid Submission Clarifications was produced. It is not known when the first version was produced but the Inquiry holds a copy of the second version which appears to be dated 15 December 2009 (the date is not stated but it is profiled as 151209 rev 2)[106]. In this document, mechanical air change rates are addressed (page 11 section 10). SHTM compliance is also addressed. The Board asks Brookfield to confirm air change rates for the ward tower. The response is:

> "A typical ward in the tower has the following air change rates to either meet the ADB requirements or achieve the environment conditions:
>
> • Bedrooms 2.5 ACH (related to ensuite extract rate and air volume for chilled beam unit loadings)
> • Ensuites 10 ACH
> • Clean Utility 6ACH
> • Disposal Hold 10 ACH
> • Pantry 6 ACH
> • Dirty Utility 10 ACH
> • Equipment store
> • Cleaner 5 ACH
> • Nurse base Up to 12 ACH to balance extract from utility spaces, etc
> • Office/meeting 4 ACH"

This response is repeated in the third version of the document[107] which appears to be dated the 17 December (the day before the Building Contract is signed). A new comment is added to the final column: "Refer to M&E Clarification Log". This Bid Submission Clarification document appears to be the source of what was then inserted into the M&E Clarification Log which is, as explained in Part 2 of this PPP, a significant contractual document in the Building Contract.

3.23.3 ZBP Ventilation Strategy Paper

On or before 15 December, ZBP (Brookfield's subconsultant) produced a document titled the "**NSGH Ward Ventilation Design Strategy**" (the "ZBP Ventilation Strategy Paper").[108] It is two pages.

This document acknowledged that the ward ventilation strategy designed by Brookfield and their subconsultants would **not** be compliant with NHS guidance.

[106] A48744521 - Bid Clarification Log (Brookfield to Board) - rev 2 - 15 December 2009.
[107] A48744495 - Bid Clarification Log (Board to Brookfield) - rev 3 - 17 December 2009 (see page 12).
[108] A32993814 - Email chain - R Ballingall and M Baird - Attaching "NSGH Ward Ventilation Design Strategy" - 15 December 2009.

It states:

“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^{o}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^{o}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."

3.23.4 Email exchanges 15/16 December 2009

- By email of 15 December 2009, Ross Ballingall of Brookfield sent the ZBP Ventilation Strategy Paper to David Hall and Mark Baird of Currie & Brown:

  "Attached latest update of M&E Log. There are a couple of bits that I still need to get an answer on but thought I would issue anyway. I have also attached a paper by ZBP on the Wards Ventilation Strategy. They have discussed this with Stuart at WW who seems to support it".

- The above email and the attached ZBP Ventilation Strategy Paper was then forwarded by Mr Baird of Currie & Brown to Karen Connelly of GGC[109]. The Inquiry has been advised that Currie & Brown representatives involved in the preparation of the ERs, competitive dialogue and contract discussions frequently

[109] A32993814 - Email chain - R Ballingall and M Baird - Attaching "NSGH Ward Ventilation Design Strategy" - 15 December 2009.

used the Project Team office as a base and documents were frequently forwarded via email to a member of the NHS GGC Project Team for the sole purpose of obtaining a printed copy. It is therefore unclear whether, notwithstanding this email, GGC were formally provided with the ZBP Ventilation Strategy Paper. However, it is noted that the Inquiry also holds another copy of the ZBP Ventilation Strategy Paper which is a "clean", non-scanned, document, and which was sent to the Inquiry by GGC[110].

- Also, on 15 December 2009, a separate email chain[111] headed "M&E log" started between Mr Baird of Currie & Brown and Stewart McKechnie of Wallace Whittle. Forwarding on the email between Mr Ballingall and Mr Baird (attaching the ZBP Ventilation Strategy Paper), Mr Baird said:

> "Stewart, If you can review and advise re ventilation + option choice on flow pipes (pros +cons of options and recommendation)".

Mr McKechnie responded:

> "Mark, On ventilation we see this as a sensible, practical solution and Energy efficient although it doesn't strictly comply with the SHTM, only further provision is that room should be kept at a neutral or slightly negative pressure as per the SHTM which needs to be incorporated in extract system sizing.
> On the water pipe resilience, which applies to all services from the energy Centre, either solution technically satisfies the ER's the100% solution probably easier to physically separate, proposals for which need to be signed off although maybe this falls into Design Development"

- The following day, 16 December 2009, Mr Baird responded. He noted "Things for today" and asked four questions including one about air changes:

> "Air changes – WW to take Board through this + specific query = **do we think SHTM 03-01 is driven by temperature or HAI for stated nr of air changes**" (bold added).

No written answer to that question appears to have been given. Mr McKechnie's response is "OK see you at 10.30 hillington".

The Inquiry does not know what Mr McKechnie said at the meeting between him and Mr Baird on 16 December, in particular whether and, if so how, he responded to the specific query about whether SHTM 03-01 is driven by temperature or hospital acquired infection risk.

The Inquiry does not hold the minutes of the Board meeting referred to by Mr Baird.

[110] A48746401 - NSGH Ward Ventilation Design Strategy paper - as submitted by GGC to Inquiry - December 2009.
[111] A48705259 - Email chain - R Ballingall, M Baird and S McKechnie - Ward Ventilation Design Strategy - Air changes - 15 to 16 December 2009.

- Later that day, Mr Baird of Currie & Brown emailed Mr McKechnie of Wallace Whittle[112] saying:

> "Think we have a way forward on this one, need a calculation carried out however tomorrow morning to prove our resolution. This involves litres per second, air changes etc and therefore requires your technical input and illustration. Can we have support for halfhour/hour in the morning please …"

The Inquiry does not hold the minutes of this meeting between Mr Baird and Mr McKechnie.

In 2016, Mr McKechnie produced a report explaining the ventilation strategy and attaching a "Current Ward Airflow diagram"[113].

The Inquiry is presently unclear whether the foregoing ZBP Ventilation Strategy Document, exchange of emails and unknown advice and calculations of Mr McKechnie of Wallace Whittle, individually or cumulatively, contributed to the decision by NHS GGC to agree (in a document called the M&E Clarification Log which became part of the Building Contract) that Brookfield would design and deliver a ventilation system which, at this stage of the Inquiry's investigations, appears to have been known to, and accepted by, both parties as being (a) not compliant with SHTM 03-01; and/or (b) a derogation from the Employer's Requirements (the "Agreed Ventilation Derogation").

As explained earlier is this PPP, this will be the subject of witness evidence and CPs have been asked to address this in the questions contained in Part 1 (Introduction) of this PPP.

3.24 2009/10 Awareness of Agreed Ventilation Derogation

The Inquiry is presently unclear about whether, or to what extent, the project team consulted or informed IP&C staff about the decision to reduce the air changes and agree to the design of a ventilation system that did not comply with SHTM 03-01.

The Inquiry is presently unclear about whether and to what extent the Estates and Facilities team were aware of the Agreed Ventilation Derogation as recorded in the M&E Clarification Log.

An email dated 23rd June 2016[114] (after handover of the hospital to GGC) reviews events around this period of time and is accordingly referred to:

[112] A48745734 - Email from M Baird to S McKechnie - NSHG air changes - 16 December 2009.
[113] A33642652 - Note from Wallace Whittle on Ward Ventilation Strategy with email exchanges from 2009, 2010 and 2016 - 18 May 2016, Bundle for Oral hearing commencing 19 August 2024 - Bundle 12 - Page 796.
[114] A33642592 - Email from A Seabourne to D Ross and others - Ventilation specification - 23 June 2016, Bundle for Oral hearing commencing 19 August 2024 - Bundle 12 - Page 813. See also A33642583 - Email from D Loudon to D Ross - SBAR Rooms air changes - 28 June 2016, Bundle for Oral hearing commencing 19 August 2024 - Bundle 12 - Page 815.

"[…] no matter what the infection control people say, they were involved in every aspect of the design and the member of my team responsible for infection control, Annette Rankin was the person responsible at design, dialogue and evaluation for ensuring that appropriate liaison and communication with the Infection Control Department and Microbiology was carried out effectively. To this end **infection control and Microbiology along with Annette were party to the sign off of all design matters that had an impact on patients** including the environment. There was no instance during the whole project time line that I can remember when I was informed this did not occur. Also, I would confirm that **Facilities Management were involved in every aspect of the design including the final sign off** of the contract documents after Dialogue and Evaluation had been completed.
Douglas's timeline is correct in that the decision on ventilation regarding the general single rooms was made at design/dialogue stage and confirmed at evaluation stage.
[…]
One of the key issues we faced from the outset of the project was that **Facilities specified that the building could not rise in temperature above 26 degrees** in the summer months (not unusual) as this had been problematic with previous new buildings such as the ACHs. As you have all seen from previous correspondence (design strategy) **this issue drove the change in ventilation design in order to achieve appropriate comfort levels and infection control as well as achieving this maximum temperature**. **This was agreed by all parties.**

Your email states that the general single rooms are not at negative pressure, although Douglas states this is not required. From my recollection, Brookfield are contracted to provide negative pressure rooms along with the agreed change in air changes. I would like to know how Brookfield tested this at commissioning and who signed it off and also, what tests the Board have done to enable them to now state the rooms are not at negative. This must have had its difficulties as the rooms were never required to be sealed with doors that do not have automatic closing devices (as agreed by all parties at the mock-up single rooms we had built) and hence can be left open, clearly removing any form of environmental control.
[…]
We are where we planned to be and if its not acceptable now then there needs to be a revised risk assessment that instructs what protocols are required to be put in place.
[…]" (bold added)

3.25 Building Contract signed

On 18 December 2009, Brookfield and Greater Glasgow Health Board entered into the Building Contract. The structure and relevant terms of the Brookfield Contract have been set out in detail in Part 2 (The Building Contract) of this PPP.

2010

3.26 Restriction of Currie & Brown's role

On 18 January 2010 (after the Building Contract was signed), NHS GGC wrote to Currie & Brown[115] setting out the fees for the next stage of project. Whereas under its original appointment, Currie & Brown had been named as the "Project Manager", under this letter Currie & Brown would now only provide "Project Management Support" as "the Board" were undertaking the role of Project Manager. The Building Contract states that Peter Moir (an employee of NHS GGC) will act as Project Manager).

On 26 February 2010, Currie & Brown responded to NHS GGC[116] and confirmed that it understood there were two key changes to Currie & Brown's appointment and fee structure for "Brookfield Construction Contract Stage 1 and Stage 2":

> "1. Responsibility for managing and administering the Building Contract sits with the Board as the designated Project Manager under the Contract and we will accept Delegated Duties as directed.
>
> 2. The requirement to direct the work of the Site Inspectorate team is no longer required. The required role of Supervisor under the NEC3 Contract will be procured separately."

3.27 Design Development Stage

Following the signing of the Brookfield Contract between Greater Glasgow Health Board and Brookfield on18 December 2009 (for Stages 1 and 2 only), there followed a period of approximately one year of design development. As set out earlier in this PPP, the contractor could not advance to Stage 3 (construction) unless the Full Business Case was approved under Stage 2.

The design development phase was described as follows at paragraph 5.14 of the Employer's Requirements:

> "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.

[115] A32660883 - Letter from NHS GGC to Currie & Brown - 18 January 2010.
[116] A32421344 - Letter from Currie & Brown to NHS GGC - 26 February 2010.

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 preconditions 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."

As set out Part 2 (The Building Contract) of this PPP, Appendix 5 to Contract Data part one also sets out the process for review of the design in similar terms to clause 5.14 of the Employer's Requirements above. Appendix 5 states that the process for review of design to be submitted by the Contractor is relation to Contractor's Proposals to ensure that it meets the Employer's Requirements" is attached. The document attached is called "Reviewable Design Data" and explains that with the Design Development process all information will be subject to review in three categories: "for approval", "for acceptance", "for comment". This procedure was to be used "to review and approve/accept/comment, as appropriate, a range of deliverables such as clinical functionality at department and room level, specifications including finishes, colour schemes, and materials and components".

3.28 Appointment of Capita Symonds as Supervisor

The Building Contract signed on 18 December 2009 stated that the NEC3 Supervisor would be Peter Moir (an employee of NHS GGC).

In February 2010, a tender process was carried out to procure a Supervisor to undertake the design and support services of an NEC3 Supervisor for the remainder of the project[117]. The stages of the project mirror the Building Contract: Stage 1 (Construct Laboratories), Stage 2 (Detailed design of hospital to FBC submission), Stage 3 (Construction), Stage 3A (Demolition surgical block and landscaping).

Following a mini procurement competition via the Frameworks Scotland Agreement, NHS GGC appointed Capita Symonds as the Project Supervisor by letter of 21 May 2010[118]. The scope of the Supervisor role was detailed within the invitation to tender. The letter confirmed that the appointment was in accordance with the NEC Professional Services Contract Option A Priced Contract with activity schedule. The commencement date was 31 May 2010. The fee for Stages 1 and 2 was fixed. The letter notes that:

> "Stages 3 and SA are subject to full business case (FBC) approval by Scottish Government in November 2010, and your commission will only

[117] A32420043 - NHS GGC High Level Information Pack - Supervisor Role - February 2010.
[118] A32421399 - NHS GGC Capita Appointment Letter (Stages 1 and 2) - 21 May 2010.

be extended to included Stages 3 and 3A once the FBC has been confirmed…"

By letter from NHS GGC to Capita Symonds dated 28 March 2011, Capita Symonds were appointed as Project Supervisor for Stage 3[119]. The commencement date was 28 March 2011. The fee for Stage 3 was fixed.

Like other professional appointments, the formal agreement was not signed until a later date. The formal agreement was signed on 28 May 2013[120]. The starting date is retrospectively agreed as 24 May 2010.

The Supervisor's duties are defined in Appendix A of the appointment: "Schedule of Duties for Supervisor." By way of broad overview, the Supervisor would provide post-contract pre-construction services. This included liaising with Brookfield and "designers" to establish the tests and inspections to be carried out; monitoring site investigation operations; informing the Project Manager of all Defects and unacceptable practices by the PSCP and other members of the supply chain; notifying the Project Manage of defects; keeping records of tests, inspections and acceptance for inclusion in the Health and Safety File as may be required by the CDM coordinator, inspect and accept Contractor enabling works, review and become acquainted with all contract documentation, and review the contractor's design proposals and provide comments to the Project Manager. At the post contract stage the Supervisor would: undertake tests and inspections (with the option to watch testing done by the Contractor) and then notify the team of results, instruct Brookfield to search for a Defect by opening up covered works and undertaking tests to demonstrate compliance, notify Brookfield of any defect identified, inform the Project Manager should Brookfield fail to correct a notified defect within the contractual defect correction period, issue the Defects Certificate recording any defects not resolved by the defects date 24 months following Completion being certified.

Appendix C of the Capital Symonds appointment is headed "Consultant and Contractor Endorsement for the Prevention of HAI for NHSScotland (HAI-SCRIBE and SHFN 30)". It contains detailed guidance as to the implementation of HAI-SCRIBE.

3.29 Gateway review 3 (investment decision)

In October 2010, the Scottish Government carried out Gateway Review 3 (Investment Decision)[121].

[119] A32421441 - NHS GGC Capita Appointment Letter (Stage 3) - 28 March 2011.
[120] A32402298 - Agreement between NHS GGC and Capita Symonds - 28 May 2013.
[121] The Inquiry does not hold a copy of this document.

3.30 Full Business Case approved

In October 2010, the Full Business Case (FBC) [122] (including appendices[123]) for the Project was submitted to the Scottish Government. It was approved in November 2010.

The FBC is a key document. Without its approval, the project could not proceed.

The FBC is a very detailed document (190 pages excluding appendices). The document details the Strategic Case, Economic Case, Commercial Case, Financial Case and Management Case for the building of the new hospitals.

Infection control, compliance with NHS guidance is addressed. Examples include:

- "…the new hospital has been designed in accordance with best practice for infection control to minimise hospital acquired infections and the associated risks" (page 37);

- …It is essential for patients with a high risk of being a source of infection to others to be managed "separately" to avoid the risk of infecting other patients. This will include; Influenza, Norovirus, Gastroenteritis, SARS, MRSA etc. This will require isolation facilities. The Infection Control Team have been fully involved in the planning of hospital to address and reduce the risk of spread of infection through the design of the facilities." (p57);

- in relation to the "Physical Environment (Compliance, Adjacencies and links)... "good levels of natural light and ventilation… compliance with NHS guidance and statutory regulation…"(page 68);

- "2I. STRATEGIC RISKS
  …
  …Headline examples of this essential activity to mitigate and manage strategic risks includes:
  …
  Control of change - There is a robust change management control mechanism in place. Requests for change need to be supported by the respective Director, and a case presented to the Acute Services Strategy Board Executive Sub Group for consideration and approval. Due to the extensive user consultation undertaken prior to tender there have been very few requests for change from users during the development of the 1:200 and 1:50 design." (page 77);

- "4A.2 Agreed Output Specifications". "The ERs include specific outputs to be met for all aspects of the construction and design, including reference to and application of NHS (e.g. Scottish Health Technical Memorandum) and other

[122] A35100876 - NHS GGC Full Business Case (public version) – October 2010 (profiled January 2011), Bundle for Oral hearing commencing 19 August 2024 - Bundle 18 Volume 1 - Page 629.
[123] A32691394 NHS GGC Full Business Case Appendices.

standards, commissioning and handover requirements, sustainability targets, treatment of arts, community engagement and benefits, plus other technical requirements, together forming a comprehensive set of requirements to be met by the contractor…." (page 108);

- "4D. AGREED KEY CONTRACT ARRANGEMENTS

  The Contract Conditions are generally in accordance with NEC3 Conditions of Contract Option C Target Price.

  Amendments were made to accommodate bidders' requirements (only insofar as did not amend NHS protection under contract) and the discussions agreed during Competitive Dialogue."

- In Table 32 "Governance Workgroups and Remits", the remit of the Technical Design Group includes managing design compliance with and derogations from ERs.

It is noted that the FBC does not appear to contain any reference to the derogation from NHS guidance in respect of the ventilation system as contained within the M&E Clarification log incorporated into the Building Contract.

It is also noted that in an email dated 21 October 2010 from Senior Nurse advisor (F. McCluskey) to various employees of NHS GGC, information is requested about ventilation in the Renal Dialysis Outpatient area as "this information is needed now as a matter of urgency for the Full Business Case".[124]

3.31 Authorisation to Proceed to Stage 3 (construction)

Greater Glasgow Health Board and Brookfield signed the Authorisation to Proceed[125] to Stage 3 (construction) on 16 December 2010. Part 2 (The Building Contract) of this PPP contains more information about this document.

2011- 2013

3.32 Brookfield appoint subcontractors

Brookfield appointed various subcontractors to carry out parts of the construction works.

A relevant subcontractor referred to in PPP 11 (water) was Mercury Engineering.

Om 19 January 2011, Brookfield Construction (UK) Limited entered into an agreement with Mercury Engineering to provide the subcontract works to stages 1 (design and construct laboratories), stage 2 (design development – new hospitals building) and stage 3 (design and construct – new hospitals building). The

[124] A48745034 - Email chain between J Hood and others - Ventilation - 15 to 25 October 2010.
[125] A32421449 - Authorisation to Proceed - 16 December 2010.

subcontract works comprised the supply, delivery, installation, commissioning and setting to work of the Mechanical, Electrical and public health systems including the partial design of such systems, all as defined in the agreement between them.

3.33 Brookfield becomes Brookfield Multiplex

On 21 February 2011, Brookfield changed its name to Brookfield Multiplex Construction Europe Limited ("Brookfield Multiplex").

3.34 ZBP replaced by Wallace Whittle

As explained earlier in this PPP, on 7 March 2013, Brookfield replaced ZBP with TUV SUD Limited (trading as "Wallace Whittle") as the MEP (mechanical, electrical and plumbing) Services Engineer.

3.35 Brookfield start on site

On 28 March 2011 Brookfield start on site.

3.36 Commissioning - Building Contract Amendment

On 8 July 2013 Project Manager's Instruction 231 (2073)[126] was issued by the Project Manager. It stated:

> **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 independence 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

Part 2 (The Building Contract) of this PPP contains the relevant terms of the Building Contract being amended. PPP12 (ventilation) is also referred to for further information.

[126] A33795364 - PMI 231 - 8 July 2013 Bundle for Oral hearing commencing 19 August 2024 - Bundle 16 - Page 1698.

3.37 Capita Symonds Limited becomes Capita Property and Infrastructure Limited

On 1 October 2013, Capita Symonds Limited became Capita Property and Infrastructure Limited.

3.38 Nightingale Associates' activities transferred to IBI

In 2014, Nightingale Associates' trade and assets were transferred to IBI and its former trading activities continued with IBI.

2015 - 2017

3.39 Sectional Completion Certificate issued

NHS GGC took possession of the building on 26 January 2015. On 29 January 2015, the Stage 3 Sectional Completion Certificate[127] was issued. It certified that sectional completion was achieved on 26 January 2015. This was four weeks earlier than the Scheduled Completion Date of 28 February 2015. Attached to the Certificate are the Supervisor's (Capita Symonds) Notification of Defects (26 January 2015) and the Project Manager's (P Moir) Schedule of Incomplete Works (26 January 2015). The defects correction period is noted as ending on 26 January 2017. The Certificate is signed by P Moir as Project Manager and J Redmond for Capita Symonds.

3.40 Brookfield Multiplex becomes Multiplex

On 31 August 2016, Brookfield Multiplex Construction Europe Limited changed its name to Multiplex Construction Europe Limited ("Multiplex").

3.41 Final Defects Certificate issued

On 26 January 2017, following the end of the two-year defects liability period, the Final Defects Certificate[128] was issued by Capita Symonds for "Stage 3 Adult and Children's Hospital and Energy Centre". It certifies that defects identified in three lists have not been corrected.

[127] A32402295 - NHS GGC Sectional Completion Certificate - 26 January 2015, Bundle for Oral hearing commencing 19 August 2024 - Bundle 12 - Page 23.
[128] A32402296 - NSGH Final Defects Certificate - 26 January 2017, Bundle for Oral hearing commencing 19 August 2024 - Bundle 15 - Page 1028.

2020

3.42 Court proceedings issued

In January 2020, following GGC's concerns with the as-built QEUH/RHC environment, Greater Glasgow Health Board commenced court proceedings in the Court of Session, Edinburgh against Multiplex Construction Europe Limited, BYP Holdings LP, Currie & Brown and Capita Property and Infrastructure Limited (the "defenders").

GGC issued a copy of the document initiating those proceedings (called a Summons[129]) to the public.

Greater Glasgow Health Board seeks to recover a sum in excess of £71 million in respect of losses alleged to have been sustained as a consequence of defects in the construction of the QEUH. Multiple breaches of the Building Contract are alleged including those relating to the water system, and ventilation in standard isolation rooms, Adult Hospital Ward 4B and RHC Ward 2A. No claim is made in relation to the ventilation of the general wards.

The Inquiry understands that the court proceedings are being actively defended.

[129] A32385266 - Summons issued by Greater Glasgow Health Board - January 2020.

Appendix A: Terms of Reference (extracts)

The issues considered in this PPP are of particular relevance to Terms of Reference 2, 3, 4 and 6

"…

2. To examine the arrangements for strategic definition, preparation and brief, and concept design, including the procurement, supply chain and contractual structure adopted for the financing and construction of the buildings, to determine whether any aspect of these arrangements has contributed to such issues and defects.

3. To examine during the delivery of QEUH and RHCYP/DCN projects:

A. Whether the Boards of NHS Greater Glasgow and Clyde and NHS Lothian put in place governance processes to oversee the projects and whether they were adequate and effectively implemented, particularly at significant project milestones;

B. Whether operational management provided by the Boards of NHS Greater Glasgow and Clyde and NHS Lothian was adequate and effective for the scale of such infrastructure projects;

C. The extent to which decision makers involved with the projects sought and facilitated the input and took account of the advice and information provided by, or available from, the clinical leadership team; infection control teams; estate teams; technical experts and other relevant parties to ensure that the built environment made proper provision for the delivery of clinical care;

D. Whether, the organisational culture within the Boards of NHS Greater Glasgow and Clyde and NHS Lothian encouraged staff to raise concerns and highlight issues in relation to the projects at appropriate times throughout the life cycles of the projects;

E. Whether failures in the operation of systems were a result of failures on the part of individuals or organisations tasked with specific functions.

4. To consider whether any individual or body deliberately concealed or failed to disclose evidence of wrongdoing or failures in performance or inadequacies of systems whether during the life of the projects or following handover, including evidence relating to the impact of such matters on patient care and patient outcomes; and whether disclosures of such evidence was encouraged, including through implementation of whistleblowing policies, within the organisations involved.

…

6. To examine, during the life cycle of the QEUH and RHCYP/DCN projects, how the Boards of NHS Greater Glasgow and Clyde and NHS Lothian secured assurance and supporting evidence that:

A. All necessary inspection and testing had taken place;

B. All key building systems had been completed and functioned in accordance with contractual specifications and other applicable regulations, recommendations, guidance, and good practice and;

C. Adequate information and training were provided to allow end-users effectively to operate and maintain key building systems.

Appendix B: Key Organisations

	GGC and their team of professional advisors
	Brookfield/Multiplex and their team of subconsultants and subcontractors

Brookfield/ Multiplex	Brookfield Construction (UK) Limited: main contractor appointed by Greater Glasgow Health Board to design and build the QEUH/RHC. After 21 February 2011, Brookfield Construction (UK) Limited became known as Brookfield Multiplex Construction Europe Limited. From 31 August 2016, it was known as Multiplex Construction Europe Limited.
Buchan	Buchan Associates: subconsultant (healthcare planner) appointed by Currie & Brown UK Limited
Capita	Capita Symonds Limited: Project Supervisor appointed by Greater Glasgow Health Board. It changed its name to Capita Property and Infrastructure Limited on 1 October 2013.
Currie & Brown	Currie & Brown UK Limited: lead consultant appointed by Greater Glasgow Health Board.
GGC	GGC is the collective term used in this PPP for Greater Glasgow Health Board; NHS Glasgow and Clyde and NHS Greater Glasgow and Clyde. Where possible, this PPP refers to the entity at the time of the event/document being discussed.
HLM	HLM Architects: subconsultant (architect advisor) appointed by Currie & Brown.
Mercury	Mercury Engineering: subcontractor appointed by Brookfield in respect of mechanical and electrical works.
Nightingale /	Nightingale Associates: architect appointed by Brookfield.

IBI	Nightingale Associates was acquired by IBI in June 2010. In 2014, Nightingale Associates' trade and assets were transferred to IBI and its former trading activities continued with IBI.
Wallace Whittle/ TUV SUD	TUV SUD Limited (trading as "Wallace Whittle"): mechanical electrical and plumbing (MEP) services engineer. Subconsultant appointed by Currie & Brown to advise Greater Glasgow Health Board. Subsequently replaced ZBP as the MEP Services Engineer appointed by Brookfield.
URS	URS Corporation Limited: subconsultant (civil and structural designer and CDM co-co-ordinator) appointed by Currie & Brown.
WSP	WSP UK Ltd: civil and structural designer appointed by Brookfield.
ZBP	Zisman Bowyer & Partners LLP: mechanical and electrical (M&E) designer appointed by Brookfield. Replaced by Wallace Whittle on 7 March 2013.

Appendix C: Timeline - key dates

2002	Acute Services Review and Strategy
2007	PSC/Design Solutions Report
	NHS GGC Design Action Plan
2008	NHS GGC investigate alternative delivery models due to lack of funding for PPP route. Two stage design and build procurement route selected
	Outline Business Case approved
	Lead Consultant (Currie & Brown) appointed to prepare the Employer's Requirements
2009	February - Project advertised for tender. Three bidders enter Competitive Dialogue stage (including Brookfield)
	May - Invitation to Participate in Competitive Dialogue (which includes the Employer's Requirements) is issued to three bidders
	August - competitive dialogue process with bidders runs from May to August 2009
	September - three bidders (including Brookfield) submit their tenders for the building contract in a document called the Contractor's Tender Return Submission
	15 December - on or around this date, GGC and Brookfield agree (in a document called the "M&E Clarification Log") that Brookfield will design and deliver a ventilation system which, at this stage of the Inquiry's investigations, appears to have been known to, and accepted by, both parties as being (a) not compliant with SHTM 03-01; and/or (b) a derogation from the Employer's Requirements (the "Agreed Ventilation Derogation") which was then incorporated into the Building Contract dated 18 December 2009
	18 December - Building Contract between GGC and Brookfield signed
2010	Design development process

	May - Capita Symonds appointed as Supervisor
	November - Full Business Case approved
	December - Authorisation to Proceed issued. Brookfield instructed to commence construction works
2011	March - Brookfield start work on site
2013	July - PMI 231 advises Brookfield can act as Independent Commissioning Engineer
2014	Pre-completion commissioning
2015	26 January **-** Sectional Completion of Stage 3 – QEUH/RHC handed over to GGC
	27 April - Adult patients were moved into the hospital
	10 June **-** Child patients were moved into the hospital
2017	26 January - End of two-year defects liability period

Provisional Position Paper 14

Queen Elizabeth University Hospital and Royal Hospital for Children

Isolation Rooms

Table of Contents

1. Purpose of the PPP

1.1 This PPP has been produced to assist the Chair in addressing the terms of reference in respect of the built environment of the Queen Elizabeth University Hospital/Royal Hospital for Children as it relates to the ventilation system.

1.2 On 13 December 2023 the Chair issued Direction 5 and indicated his intention that the Inquiry should answer four Key Questions by leading evidence at the Glasgow III hearing due to commence on 19 August 2024 so that those Key Questions can be answered using that evidence along with the evidence from the hearing in the autumn of 2021 ("Glasgow I"); the hearing in the summer of 2023 ("Glasgow II"); all relevant Provisional Position Papers (PPP); and the evidence led in respect of ventilation principles and practice at hearings of the Inquiry in respect of Royal Hospital for Children and Young People/Department of Clinical Neurosciences.

1.3 The Inquiry is aware that within the construction contract between Greater Glasgow Health Board ("NHS GGC") and Multiplex Construction Europe Limited ("Multiplex")("the Contract"), the word "Defect" is a defined term. The definition of a Defect in the Contract is different from the concept that is addressed in the Key Questions. A separate PPP 13 has been produced which has analysed the Contract to the extent that is necessary to answer the Inquiry's Terms of Reference.[1]

[1] Clause 11.2 (5) of the Contract defines a "Defect" as: a part of the *works* which is not in accordance with the Works Information or a part of the *works* designed by the *Contractor* which is not in accordance with the applicable law or the *Contractor's* design which the *Project Manager* has accepted. This document is not produced with this PPP.

2. Procedure to be adopted

2.1 The Chair is likely to be invited to by the Inquiry Team to make findings in fact based on the content of this PPP. Any Core Participant or any other person holding relevant information is invited to seek to correct and/or contradict any material statement of fact which it considers to be incorrect and to point to what evidence exists to support the position taken by the Core Participant or other person. It follows that the Inquiry's understanding of matters set out in this PPP may change and so this paper is provisional.

2.2 Subsequent Inquiry hearings may touch on some of the matters to a varying extent contained within this PPP, but they may not; if parties wish to address the issues dealt within in this PPP, then they are invited to do so now. In the absence of a response on a matter, the Chair is likely to be invited by the Inquiry Team to make findings in fact based on the content of this PPP.

2.3 Please be aware that all responses to this PPP received by the Inquiry will be published on its website as soon as possible after the deadline for responses has passed.

3. Contractual Context

3.1 Whilst a separate PPP has analysed the Contract to the extent that it is necessary to answer the Inquiry's full terms of reference, some reference must be made to some of the contractual documents in this PPP, namely:

a) Volume 2/1 Employer's Requirements, with relevant Clinical Output Specifications from Appendix B;
b) Contract Data Part One, Appendix 5;
c) The M&E Clarification Log (2010 ItP) Final.

3.2 In addition to the above key contractual documents, a wide range of documents containing information about the features of the ventilation system are referred to within the Contract which include:

3.3 Clinical Output Specification (COS)

A COS is a document prepared by clinical staff and NHS GGC staff who have expertise in the relevant ward, on what to install in that specific ward. COSs relevant to each ward, have been included throughout the paper.

3.4 Room Data Sheets (RDS)

The Activity Database ("ADB") system is a standardised hospital design tool used by the NHS in the UK. It is a digital database of hospital design information including detailed requirements for clinical spaces in hospitals. It can be used to create a Room Data Sheet ("RDS"). Every room in a hospital project will have its own individual RDS that captures the fundamental elements (number of sockets, ventilation air change rate, provision of fire alarm etc)[2].

The ventilation parameters appear on a RDS for the room environmental data along with others such as lighting and noise parameters. When RDS are generated from the ADB, the ventilation parameters will in most cases be derived from HTM 03-01 Part A (2007).

[2] **A44456845** - CSCIE, Closing Submission by Counsel to the Inquiry - Paragraph 68

3.5 Environmental Matrix

To facilitate communication about environmental parameters, engineers devised an Environmental Matrix[3]. This is a spreadsheet which gathers together in one place, for all rooms in a building, certain parameters bearing upon its mechanical and electrical engineering systems.

3.6 Reviewable Design Data (RDD).

The Contract contained a process for the review of certain design deliverables such as clinical functionality, specifications including finishes, colour schemes, materials and components referred to as Reviewable Design Data ("RDD").

3.7 External design and construction standards

NHS Guidance has been evolving over many decades[4] with certain guidance being superseded completely (for example, the SHTM 03-01 series superseded the SHTM 2025 series in February 2013[5]) while other guidance was updated so there were more recent versions (for example, the SHTM 03-01 issued in 2013 was subsequently revised and reissued in 2014 and then again in February 2022).

3.8 The NHS Guidance includes the following types of guidance:

3.8.1 Scottish Health Technical Memoranda (SHTM): These 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[6].

[3] **A44456845** - CSCIE, Closing Submission by Counsel to the Inquiry - Paragraph 72
[4] **A43958336** - Statement of Edward McLaughlan for Edinburgh Hearing on 9 May 2022. - Scottish Hospitals Inquiry - Hearing commencing 9 May 2022 - Witness Statement Bundle - Paragraph 6, Page 3; **A43957166** - 10 May 2022 - Transcript - Andrew Poplett - Bundle 6 - Expert Reports and Statement - Page 3097, Paragraph 9
[5] Note that the Draft for Consultation SHTM 03-01 Part A Design and Validation was produced in March 2009 and fell within the NHS Guidance applicable at the time of the contract. The final approved and published version of the draft guidance applied from February 2013.
[6] **A43958336** - Statement of Edward McLaughlan for Edinburgh Hearing on 9 May 2022. - Scottish Hospitals Inquiry - Hearing commencing 9 May 2022 - Witness Statement Bundle - Paragraph 16, Page 6

3.8.2 Scottish Health Facilities Notes (SHFN): These give comprehensive guidance on the operation of healthcare facilities. The topics within the group of guidance includes infection prevention and control, cleaning services frameworks, security, and health and safety[7].

3.8.3 Scottish Health Planning Notes (SHPN): These give comprehensive guidance on the operation of healthcare facilities. The topics within the guidance include planning for in-patient facilities for both adults and children, accident and emergency facilities, and isolation facilities[8].

3.8.4 Scottish Health Technical Notes (SHTN): These provide comprehensive guidance on a range of healthcare specific standards, policies and current best practice[9].

3.8.5 Health Building Notes (HBN)[10]: These provide best practice guidance on the design and planning of new healthcare buildings and on the adaptation or extension of existing facilities[11].

3.8.6 Health Technical Memoranda (HTM[12]): These provide guidance for anyone involved in the design, installation or operation of healthcare ventilation. Their primary focus is as engineering technical documents but they include contributions from not only engineers, but also infection prevention control specialists and manufacturers[13].

3.9 An NHS body procuring a new hospital must develop a project brief that should ordinarily specify that the design and build is in compliance with the above NHS Guidance[14]. However, derogations from the guidance documents may be

[7] **A43958336** - Statement of Edward McLaughlan for Edinburgh Hearing on 9 May 2022. - Scottish Hospitals Inquiry - Hearing commencing 9 May 2022 - Witness Statement Bundle - Paragraph 16, Page 6
[8] **A43958336** - Statement of Edward McLaughlan for Edinburgh Hearing on 9 May 2022. - Scottish Hospitals Inquiry - Hearing commencing 9 May 2022 - Witness Statement Bundle - Paragraph 16, Page 6
[9] **A43958336** - Statement of Edward McLaughlan for Edinburgh Hearing on 9 May 2022. - Scottish Hospitals Inquiry - Hearing commencing 9 May 2022 - Witness Statement Bundle - Paragraph 16, Page 6
[10] HBNs are derived from NHS Improvement in England but approved by Health Facilities Scotland for use in Scotland. To be clear, unlike the other guidance notes, there is no separate Scottish document.
[11] **A43958336** - - Statement of Edward McLaughlan for Edinburgh Hearing on 9 May 2022. - Scottish Hospitals Inquiry - Hearing commencing 9 May 2022 - Witness Statement Bundle 2022 - Paragraphs 16-17, Pages 6-7
[12] This is a document applicable only in England and Wales but the Scottish SHTM is based on this. The HTM was included in the NHS Guidance and applied to the QEUH and RCH on a contractual basis.
[13] **A38010349** - 10 May 2022 - Transcript - Andrew Poplett - Bundle 6 - Expert Reports and Statement - Page 3097, Paragraph 8 & Paragraph 65
[14] **A37465696** - Expert Report of Stephen Maddocks - Bundle 6 - Expert Reports and Statement - Page 68

agreed at the time of the contract[15]. The requirements of NHS Guidance are the fundamental starting block of any hospital design[16]. They are the best practice guidance for hospital design[17].

3.10 There are legitimate and sound reasons why contractual parties may decide to derogate but the derogation should be assessed, and the implications considered[18]. The derogation from NHS Guidance should be fully documented and recorded in the project file and the record maintained for the life of the building[19]. A derogation from NHS Guidance that could impact on patient or staff safety should never be undertaken[20].

3.11 Statutory Compliance

The ventilation system in the relevant wards also required to comply with statutes and regulations[21].

- The *Health and Safety at Work etc Act 1974* is one of the statutes that falls within the list in the Employer's Requirements and is relevant given that the ventilation system is intended to prevent contamination, closely control the environment, dilute contaminants and contain hazards[22].

- The ventilation system must also comply with the *Building (Scotland) Regulations 2004*. Building Standard 3.14 covers ventilation and states that:

> *"Every building must be designed and constructed in 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".*[23]

3.12 In accordance with the Scottish Building Standards, the minimum mechanical ventilation requirement for an occupied space is to provide an average

[15] **A37465696** - Expert Report of Stephen Maddocks - Bundle 6 - Expert Reports and Statement - Page 68
[16] **A37465696** - Expert Report of Stephen Maddocks - Bundle 6 - Expert Reports and Statement - Page 68
[17] **A37465696** - Expert Report of Stephen Maddocks - Bundle 6 - Expert Reports and Statement - Page 70
[18] **A43957166** - Oral evidence of Andrew Poplett, Hearing on 10 May 2022 - PPP 6 - Commissioning and Validation - Footnote bundle, Page 3159.
[19] **A43957166** - Oral evidence of Andrew Poplett, Hearing on 10 May 2022 - PPP 6 - Commissioning and Validation - Footnote bundle, Page 3159.
[20] **A43957166** - Oral evidence of Andrew Poplett, Hearing on 10 May 2022 - PPP 6 - Commissioning and Validation - Footnote bundle, Page 3160.
[21] **A33010628** - Employer's Requirements, Section 5.0 (General Design and Construction Requirements) [Additional Guidance] - Scottish Hospitals Inquiry - Hearing Commencing 19 August 2024 - Bundle 18 - Documents referred to in the expert report of Dr J.T. Walker - Volume 1 (of 2) - Paragraph 5.1.4
[22] **A44456845** - CSCIE, Closing Submission by Counsel to the Inquiry - Paragraph 43
[23] **A44456845** - CSCIE, Closing Submission by Counsel to the Inquiry - Paragraph 44

eight litres of fresh air per person per second[24]. There is no further specification in the Scottish Building Standards as to the air quality for a building such as a hospital.

4. Introduction

4.1 Among the reasons for providing ventilation in healthcare premises is: (1) the need to isolate patients who represent a biological, chemical or radiation hazard to others; and (2) isolate patients with a reduced immune system.[25] It is recommended for such patients to be accommodated in isolation facilities with specialised ventilation requirements. [26] As well as individual rooms, 'Isolation facilities' include:

- infectious disease units,
- bone marrow and other transplant units
- chemotherapy and oncology units.

4.2 From an infection control perspective, there are two main reasons for treating patients in isolation rooms:

- where a patient poses an infection risk to others;
- where a patient is susceptible to infection from other sources.[27]

4.3 Isolation rooms may have a ventilation system that provides a positive pressure in the room to protect the patient from infection, a negative pressure to

[24] **A47128231** - Mechanical Ventilation, Environment (Non-domestic buildings, Technical Handbook 2017). - Scottish Hospitals Inquiry - Hearing Commencing 19 August 2024 - Bundle 16 - Ventilation PPP - Page 1202, Section 3.14.5
[25] **A47836358** - Hearings commencing 19 August 2024 - Scottish Hospitals Inquiry - Hearing Commencing 19 August 2024 - Bundle 16 - Ventilation PPP - Page 355; **A37399586** - Hearing Commencing 9 May 2022 - Scottish Hospitals Inquiry - Hearing Commencing 19 August 2024 - Bundle 16 - Ventilation PPP - Page 445 & 630
[26] **A47836358** - Hearings commencing 19 August 2024 - Scottish Hospitals Inquiry - Hearing Commencing 19 August 2024 - Bundle 16 - Ventilation PPP - Page 425; **A37399586** - Hearing Commencing 9 May 2022 - Scottish Hospitals Inquiry - Hearing Commencing 9 May 2022 - Bundle 1 - Scottish Health Technical Memoranda - Page 515 & 699
[27] **A47836358** - Hearings commencing 19 August 2024 - Scottish Hospitals Inquiry - Hearing Commencing 19 August 2024 - Bundle 16 - Ventilation PPP - Page 320; **A37399586** - Hearing Commencing 9 May 2022 - Scottish Hospitals Inquiry - Hearing Commencing 9 May 2022 - Bundle 1 - Scottish Health Technical Memoranda - Page 257.

prevent a patient from infecting others, or ventilation that is switchable from positive to negative pressure.[28] The provision of switchable ventilation is not recommended due to the risk of cross-contamination if the setting is incorrect.[29]

4.4 Scottish Health Technical Memoranda (SHTM) 03-01 (various versions have been issued starting with a draft version in 2009 up to the most recent 2022 version) provides comprehensive advice and guidance on the legal requirements, design implications, and maintenance and operation of specialised ventilation in healthcare premises.[30]

4.5 In the versions of SHTM 03-01 (draft 2009, 2013, and 2014) that applied during design and construction of the Queen Elizabeth University Hospital (QEUH), infectious disease isolation rooms were recommended to have 10 air changes per hour (ACH) of mechanical extract ventilation and -5 pascals pressure relative to the corridor. Neutropenic patient wards and Critical Care areas were recommended to have 10 ACH of mechanical supply ventilation and +10 pascals pressure relative to surrounding areas (although the guidance noted that isolation rooms could be negative pressure).[31] Isolation facilities in general required High Efficiency Particulate Air (HEPA) filtration,[32] and windows and trickle vents needed to be sealed to maintain pressure regimes.[33]

[28] **A47836358** - Hearings commencing 19 August 2024 - Scottish Hospitals Inquiry - Hearing Commencing 19 August 2024 - Bundle 16 - Ventilation PPP - Page 320; **A37399586** - Hearing Commencing 9 May 2022 - Scottish Hospitals Inquiry - Hearing Commencing 9 May 2022 - Bundle 1 - Scottish Health Technical Memoranda - Page 257.
[29] **A47836358** - Hearings commencing 19 August 2024 - Scottish Hospitals Inquiry - Hearing Commencing 19 August 2024 - Bundle 16 - Ventilation PPP - Page 320; **A37399586** - Hearing Commencing 9 May 2022 - Scottish Hospitals Inquiry - Hearing Commencing 9 May 2022 - Bundle 1 - Scottish Health Technical Memoranda - Page 257.
[30] **A47836358** - Hearings commencing 19 August 2024 - Scottish Hospitals Inquiry - Hearing Commencing 19 August 2024 - Bundle 16 - Ventilation PPP - Page 352; **A37399586** - Hearing Commencing 9 May 2022 - Scottish Hospitals Inquiry - Hearing Commencing 9 May 2022 - Bundle 1 - Scottish Health Technical Memoranda - Page 442
[31] **A47836358** - Hearings commencing 19 August 2024 - Scottish Hospitals Inquiry - Hearing Commencing 19 August 2024 - Bundle 16 - Ventilation PPP - Page 483; **A37399586** - Hearing Commencing 9 May 2022 - Scottish Hospitals Inquiry - Hearing Commencing 9 May 2022 - Bundle 1 - Scottish Health Technical Memoranda - Page 573 & 756
[32] **A47836358** - Hearings commencing 19 August 2024 - Scottish Hospitals Inquiry - Hearing Commencing 19 August 2024 - Bundle 16 - Ventilation PPP - Page 401; **A37399586** - Hearing Commencing 9 May 2022 - Scottish Hospitals Inquiry - Hearing Commencing 9 May 2022 - Bundle 1 - Scottish Health Technical Memoranda - Page 489 & 673
[33] **A47836358** - Hearings commencing 19 August 2024 - Scottish Hospitals Inquiry - Hearing Commencing 19 August 2024 - Bundle 16 - Ventilation PPP - Page 430; **A37399586** - Hearing Commencing 9 May 2022 - Scottish Hospitals Inquiry - Hearing Commencing 9 May 2022 - Bundle 1 - Scottish Health Technical Memoranda - Page 520 & 704

4.6 For ‘Ward Isolation room’ parameters SHTM 03-01 directed readers to Health Building Note (HBN) 4: Supplement 1 (2005), and in later editions, Scottish Health Planning Note (SHPN) 4: Supplement 1 (2008). These documents provided the same substantive guidance on the facilities required for isolating patients on acute general wards.[34] The Scottish-specific SHPN will therefore be referred to unless otherwise stated.

4.6.1 The purpose of the SHPN 04 Supplement 1 guidance is stated in paragraph 1.4 as:

> “This Supplement to SHPN 04: ‘In-patient accommodation: options for choice’, provides guidance on the facilities required for isolating patients on acute general wards.”

4.7 Paragraph 1:8 confirms:

> “The guidance on isolation suites in this Supplement is based on a validated design model. 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.”

4.8 According to the SHPN:

> “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 HAI [Healthcare Associated Infection]. 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”.[35]

[34] **A47836358** - Hearings commencing 19 August 2024 - Scottish Hospitals Inquiry - Hearing Commencing 19 August 2024 - Bundle 16 - Ventilation PPP - Page 319; **A37399586** - Hearing Commencing 9 May 2022 - Scottish Hospitals Inquiry - Hearing Commencing 9 May 2022 - Bundle 1 - Scottish Health Technical Memoranda - Page 225
[35] **A37399586** - Hearing Commencing 9 May 2022 - Scottish Hospitals Inquiry - Hearing Commencing 9 May 2022 - Bundle 1 - Scottish Health Technical Memoranda - Page 255

4.9 One aim of the document was to set a standard for new-build facilities.[36] Although the guidance narrated in the HBN was based on a theoretical design model, this had been validated by the publication of the SHPN.[37]

4.10 As well as describing how a single room with en-suite sanitary facilities could be enhanced to provide effective isolation for patients with infections transmitted through non-airborne routes, the guidance explained how an enhanced single room with en-suite facilities and a ventilated lobby - known as a Positive Pressure Ventilated Lobby (PPVL) - could provide an isolation suite for patients with airborne infections or a need to be protected from them:[38]

> "The ventilated bed access 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.
>
> As 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."[39]

[36] **A37399586** - Hearing Commencing 9 May 2022 - Scottish Hospitals Inquiry - Hearing Commencing 9 May 2022 - Bundle 1 - Scottish Health Technical Memoranda - Page 255
[37] **A47836358** - Hearings commencing 19 August 2024 - Scottish Hospitals Inquiry - Hearing Commencing 19 August 2024 - Bundle 16 - Ventilation PPP - Page 319; **A37399586** - Hearing Commencing 9 May 2022 - Scottish Hospitals Inquiry - Hearing Commencing 9 May 2022 - Bundle 1 - Scottish Health Technical Memoranda - Page 256
[38] **A37399586** - Hearing Commencing 9 May 2022 - Scottish Hospitals Inquiry - Hearing Commencing 9 May 2022 - Bundle 1 - Scottish Health Technical Memoranda - Page 255
[39] **A37399586** - Hearing Commencing 9 May 2022 - Scottish Hospitals Inquiry - Hearing Commencing 9 May 2022 - Bundle 1 - Scottish Health Technical Memoranda - Page 261 - 262

4.11 The HBN and SHPN proposed a design for enhanced single rooms and PPVL rooms,[40] but provided the following exclusion:

> "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".[41]

4.12 The Inquiry Team understand that these further supplements were not produced.[42]

4.13 The engineering philosophy set out for PPVL rooms aimed to provide a "fail-safe" design solution.[43] The SHPN provided:

> "The ventilation system is designed on the basis that all its constituent parts, as described in Table 1, 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 airflow through the entire isolation suite. Similarly, the volumetric airflow rate in the lobby is determined by the number of air changes required in the patient's bedroom. Modifying or failing to provide one element of the system will jeopardise the performance of the system as a whole."[44]

4.14 Basic design parameters were then narrated for isolation rooms:

[40] **A47836358** - Hearings commencing 19 August 2024 - Scottish Hospitals Inquiry - Hearing Commencing 19 August 2024 - Bundle 16 - Ventilation PPP - Page 320; **A37399586** - Hearing Commencing 9 May 2022 - Scottish Hospitals Inquiry - Hearing Commencing 9 May 2022 - Bundle 1 - Scottish Health Technical Memoranda - Page 257
[41] **A47836358** - Hearings commencing 19 August 2024 - Scottish Hospitals Inquiry - Hearing Commencing 19 August 2024 - Bundle 16 - Ventilation PPP - Page 319; **A37399586** - Hearing Commencing 9 May 2022 - Scottish Hospitals Inquiry - Hearing Commencing 9 May 2022 - Bundle 1 - Scottish Health Technical Memoranda - Page 256
[42] **A47287839** - Hearings commencing 26 February 2024 - Hearing Commencing 26 February 2024 - Bundle 13 - Miscellaneous - Volume 8 - Page 603
[43] **A47836358** - Hearings commencing 19 August 2024 - Scottish Hospitals Inquiry - Hearing Commencing 19 August 2024 - Bundle 16 - Ventilation PPP - Page 325; **A37399586** - Hearing Commencing 9 May 2022 - Scottish Hospitals Inquiry - Hearing Commencing 9 May 2022 - Bundle 1 - Scottish Health Technical Memoranda - Page 267
[44] **A37399586** - Hearing Commencing 9 May 2022 - Scottish Hospitals Inquiry - Hearing Commencing 9 May 2022 - Bundle 1 - Scottish Health Technical Memoranda - Page 267

> "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.
> …
> "Where immuno-compromised patients are to be accommodated, such as in transplant units or specialist cancer units, there could be a need for positive pressure isolation rooms."[45]

4.15 The following were included among further design/engineering requirements:

- "sealed, solid ceiling; windows to the exterior and interior to be locked shut and sealed".[46]

- "Ideally each suite should have its own dedicated supply and extract system."[47] However: "In a high-rise building a common supply and extract system may be the only feasible solution."[48]

- "An extract terminal should be fitted at high level in the en-suite room. An additional terminal may be fitted in certain circumstances at low level adjacent to the bedhead in the bedroom."[49]

- "A G3 pre-filter and final filter should be fitted in the [supply] AHU (Air Handling Unit). 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

[45] **A37399586** - Hearing Commencing 9 May 2022 - Scottish Hospitals Inquiry - Hearing Commencing 9 May 2022 - Bundle 1 - Scottish Health Technical Memoranda - Page 267 & 268
[46] **A37399586** - Hearing Commencing 9 May 2022 - Scottish Hospitals Inquiry - Hearing Commencing 9 May 2022 - Bundle 1 - Scottish Health Technical Memoranda - Page 263
[47] **A37399586** - Hearing Commencing 9 May 2022 - Scottish Hospitals Inquiry - Hearing Commencing 9 May 2022 - Bundle 1 - Scottish Health Technical Memoranda - Page 268
[48] **A37399586** - Hearing Commencing 9 May 2022 - Scottish Hospitals Inquiry - Hearing Commencing 9 May 2022 - Bundle 1 - Scottish Health Technical Memoranda - Page 269
[49] **A37399586** - Hearing Commencing 9 May 2022 - Scottish Hospitals Inquiry - Hearing Commencing 9 May 2022 - Bundle 1 - Scottish Health Technical Memoranda - Page 269

HEPA filter will be routinely required, this arrangement will allow for subsequent fitting when appropriate".[50]

- "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."[51]

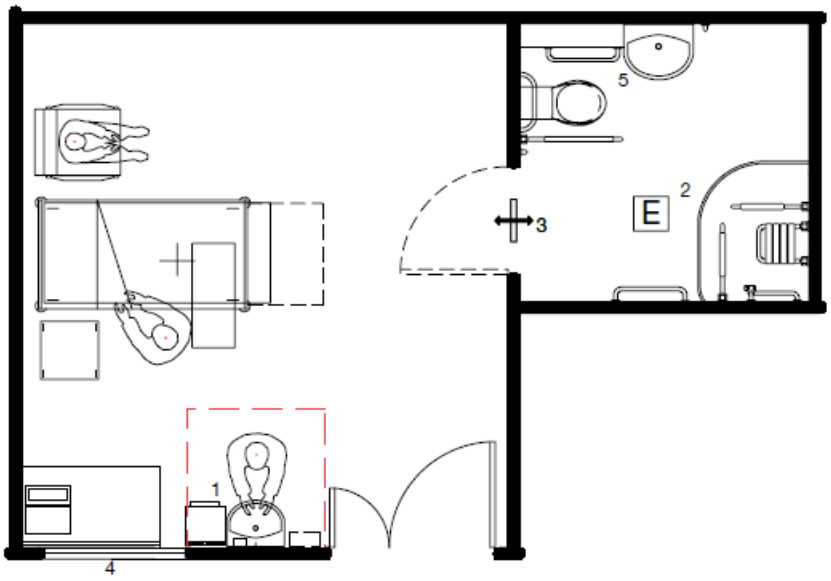
4.16 Although it was noted that other room configurations were possible, Appendices to the guidance provided example room layouts, together with a list of minimum requirements for each room. These are reproduced below. Sheet 1 indicated a proposed layout for enhanced single rooms; Sheet 2 proposed a layout for PPVL rooms.[52]

[50] **A37399586** - Hearing Commencing 9 May 2022 - Scottish Hospitals Inquiry - Hearing Commencing 9 May 2022 - Bundle 1 - Scottish Health Technical Memoranda - Page 270
[51] **A37399586** - Hearing Commencing 9 May 2022 - Scottish Hospitals Inquiry - Hearing Commencing 9 May 2022 - Bundle 1 - Scottish Health Technical Memoranda - Page 271
[52] **A47836358** - Hearings commencing 19 August 2024 - Scottish Hospitals Inquiry - Hearing Commencing 19 August 2024 - Bundle 16 - Ventilation PPP - Page 329 - 331; **A37399586** - Hearing Commencing 9 May 2022 - Scottish Hospitals Inquiry - Hearing Commencing 9 May 2022 - Bundle 1 - Scottish Health Technical Memoranda - Pages 274 - 276

Use of Single Rooms for Isolation: Key Design Principles

Sheet 1

New build single room with en-suite facilities



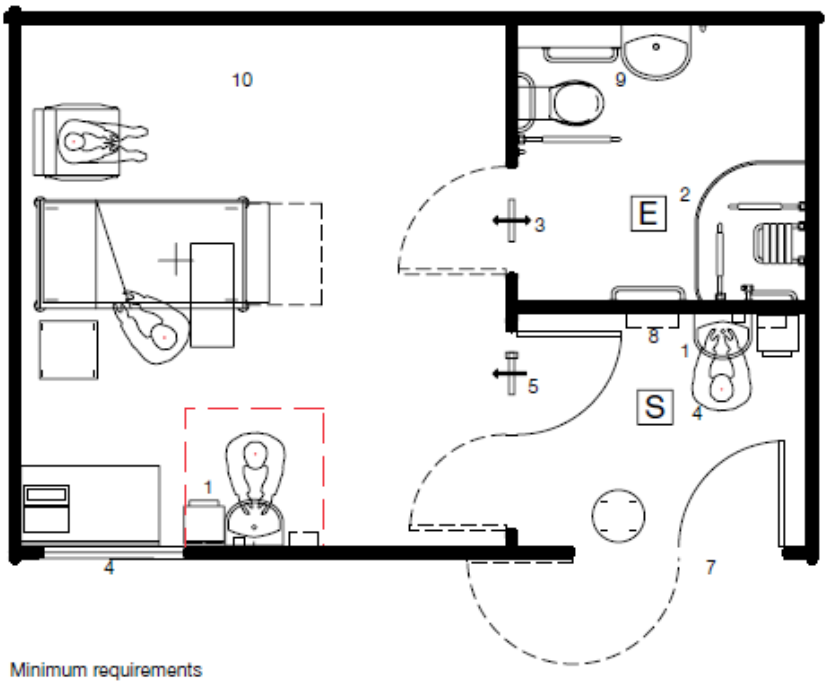
Minimum requirements

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

Sheet 2

New build single room with en-suite facilities and lobby



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

QEUH Isolation Rooms and Specialised Ventilation (including move of Brownlee and Beatson Units into QEUH)

5. Introduction (QEUH section)

5.1 In 2009, at the Invitation to Participate in Dialogue ("ITPD") stage, there were four wards to be located on Level 5 of the New South Glasgow Hospital (hereafter referred to as "the QEUH"). These wards were as follows: Rheumatology, ENT (Ear, Nose and Throat) and two "Generic Wards"[53].

5.2 The Employer's Requirements ("ERs") of the contract specified that each 28 bed ward within the Adult Acute Hospital would be provided with a single isolation room[54]. In the QEUH, the Schedule of Accommodation (SoA) outlined six areas of the hospital with 28 beds or more. These were: Generic Wards (28 beds), ENT ward (28 beds), Rheumatology ward (28 beds), Acute Assessment Cluster (28 beds), Acute Cluster (30 beds), and General Receiving Cluster (48 beds) within the Acute Admissions Unit.

5.3 The SoA did not make specific provision for isolation rooms in 28 bed wards. For example, the number of beds in Generic Wards is given as 28 but these are set out as 'Acute single bedrooms (incl family & clinical support space)' with ADB Code B0303. Provision is made for one 'Gowning lobby: single bedroom'. (no ADB code is provided for this room) but not an isolation room. Rooms with code B0303A do not refer to patient isolation, ACH or pressure requirements. All references to isolation rooms in generic ADB sheets have room code B1602 which does include mechanical ventilation requirements; namely 6 ACH and balanced pressure to adjoining space.

5.4 The departmental plans (1:200s) supplied with the procurement documents are not sufficiently detailed to show whether isolation rooms were provided on each 28 bed ward[55].

[53] **A35772438** - 1:500 Tender Plan Level 5, 6 July 2009; **A32962483** - NSGH Client Familiarisation Building (undated).
[54] **A32994127** - [Ventilation of Isolation Rooms], ITPD Volume 2 - Clause 8.2.15.1
[55] **A35773999** - NA-xx-04-PL-252-000; Fourth Floor Department Layout (1:200)

5.5 The ERs included Clinical Output Specifications ("COS") which stated a requirement in General Adult Ward areas for 1 room per ward to be used for isolation purposes with an associated gowning lobby[56]. For example, in the Rheumatology COS, services will be provided from: "…*the Generic Outpatient Clinics, Generic Wards, and from the Medical Day Unit"*[57]*.* In the ENT COS, it is stated that services will be provided from: "…*generic wards, generic theatres, and dedicated specialist outpatient facilities*[58]". In paragraph 6.2 of the Generic COS, it is stated that *"[Environmental and Services Requirements] should correspond to the standards described in relevant SHPNs, HTMs and other technical guidance and the technical output specification for this project*.[59]"

5.6 In May 2009, the Inquiry Team understands that NHS GGC agreed to different provision of isolation rooms and clarified this change with bidders during competitive dialogue[60]. This change is confirmed in an email stating: "There are no lobbied bedrooms in the adult tower…This was agreed in 2009 with microbiologist/ICT involvement"[61]. Accordingly, an isolation room on each 28 bed ward as anticipated in the Employer's Requirements was not provided[62]. In September 2009, the en-suite rooms on Level 5 were designed to be general ward rooms[63]. The status of the level 5 wards and rooms did not change throughout the design development stage. In 2014, it is noted that the four wards on level 5 remained as "Generic Wards"[64].

5.7 In 2013, the ventilation parameters for the Level 5 isolation rooms were specified in the Data Sheet as 6 ACH supply in the acute single bedroom (including family and clinical support space) and 10 ACH extract of the inpatient en-suite room. However the corresponding Mechanical Ventilation Notes in the Data Sheet stated that the supply air rate is 40 litres per second (which the Inquiry

[56] **A35761946** - New South Glasgow Hospital, Clinical Output Specification, Generic Adult Wards - Scottish Hospitals Inquiry - Hearing Commencing 19 August 2024 - Bundle 16 - Ventilation PPP - Page 1655
[57] **A35184837** - Rheumatology Clinical Output Specification
[58] **A35761885** - ENT Audiology Clinical Output Specification
[59] **A35761949** - NSGACL Generic Wards NSG_iss1_rev (undated) - Scottish Hospitals Inquiry - Hearing Commencing 19 August 2024 - Bundle 16 - Ventilation PPP - Page 1634
[60] **A36372543** - NHS GGC Infection Control Meeting - 18 May 2009 - Pages 1-2; **A36372525**, A13 – Clarification issued to bidders re' (undated).
[61] **A49386768 -** Email chain between C Williams, J Brown, S McNamee, F McCluskey regarding Highly Infectious patents in the NSGH and other issues - 11 to 12 August 2014
[62] **A32994127** - [Ventilation of Isolation Rooms], ITPD Volume 2
[63] **A35773717** - 1:200 Tender Plan Level 5 – Atrium and lift core - 2 September 2009.
[64] **A33501458** - 20140609 Fifth Floor Plan - 9 June 2014..

Team understands equates to approximately 2.5-3 ACH)[65]. It is further stated that the bedroom is balanced or negative pressure to the adjoining corridor while the bedroom is positive with respect to the en-suite sanitary room[66].

5.8 In July 2014, it is noted that in relation to lobbied isolation rooms, the position in the QEUH adult hospital was as follows[67]:

NSGH	Critical Care	10 no.
	Renal (higher acuity)	2no.
	Haemato-oncology (HEPA filtration – not lobbied)	24no.

5.9 Each lobbied isolation room should have been provided with its own dedicated ventilation system in line with SHBN 04[68]. However, Professor Williams confirmed there was no infection control risk with positive pressure ventilated lobby rooms ("PPVL")[69].

5.10 Wallace Whittle confirmed prior to handover in January 2015 that isolation rooms throughout the hospital had been designed in line with SHPN 04 Supplement 1. They further confirmed that they saw no reason why the isolation rooms could not be used under the guidance issued previously by the NHS[70].

5.11 The COS for Adult Isolation Rooms stated that the QEUH's Haemato-oncology ward would be sealed with HEPA filtration and highly filtered air (to H13 standard).

[65] **A49413350 -** Tower Room Data - WW Comments 20130725 - Excerpt of A47946602 edited for relevant information
[66] **A49413350 -** Tower Room Data - WW Comments 20130725 - Excerpt of A47946602 edited for relevant information
[67] **A49392066** - Email chain between Fiona McCluskey and Pamela Joannidis about lobbied isolation rooms - dated 03 July 2014
[68] **A36939897** - ZBP Engineering Services Specification - August 2012 – Page 18.
[69] **A32221628** - BICC Minutes, 30 March 2015 - Scottish Hospitals Inquiry - Hearing Commencing 24 April 2023 - Bundle 13 - Witness Statements - Page 235
[70] **A38694871** - SBAR dated 26 April 2016 - Timeline ID SGUH - Scottish Hospitals Inquiry - Bundle of Documents for the Oral Hearing Commencing 12 June 2023 - Bundle 4 - NHS Greater Glasgow and Clyde: Situation, Background, Assessment, Recommendation (SBAR) Documentation

6. NHS Guidance for Isolation Rooms

6.1 The ERs of the building contract specified that the air conditioning systems to the isolation rooms would support the ERs, COS and NHS infection control standards with strict positive / negative pressure differentials[71]. Each isolation suite lobby was required by the ERs to have a simple to read digital differential pressure gauge[72].

6.2 The issue of validation is addressed in NHS guidance, namely (Draft for Consultation) SHTM 03-01 Part A (2009). It states that it is: "*a process of proving that the system is fit for purpose and achieves the operating performance originally specified*…[73]".

6.3 The ventilation and air conditioning rooms systems for the isolation rooms required to be designed and installed in accordance with:

- SHTM 2025
- SHTM 2040
- SHPN 4; and
- NHS Model Engineering Specification C04[74].

6.4 There is no current NHS guidance providing recommendations on the ventilation system for single (or multi-bed) rooms in an IDU. An exclusion in SHPN 04 Supplement 1 states the guidance on PPVL isolation rooms does not apply to infectious disease isolation. SHTM 03-01 (draft 2009) and HTM 03-01 (2007) recommend 10 ACH and 5 Pa for IDU isolation rooms.

[71] **A32994127** - [Ventilation of Isolation Rooms], ITPD Volume 2 - Clause 8.2.15.4
[72] **A32994127** - [Ventilation of Isolation Rooms], ITPD Volume 2. - Clause 8.2.15.5
[73] **A33010802** - NSGACL SHTM 03-01 Part A_iss1_rev - Scottish Hospitals Inquiry - Hearing Commencing 19 August 2024 - Bundle 16 - Ventilation PPP - Page 459
[74] **A32994127** - [Ventilation of Isolation Rooms], ITPD Volume 2 - Clause 8.2.15.7

6.5 In accordance with the ERs[75], the isolation rooms required to comply with 'SHPN 04 Supplement 1: Isolation facilities in acute settings (September 2008). HEPA filter is not routinely required. The patient room and the ensuite should have 10 ACH. A flow sensor is required to be fitted to each system that will alarm on fan failure at a designated nurse station and the estates department. A pressure stabiliser should be fitted above the door between the lobby and the bedroom. The ceiling should be of a sealed solid construction. Validation of isolation suites are required with an average leakage rate of not more than 1l/s of air per 1m3 of envelope volume.'

6.6 In accordance with the ERs[76], the isolation rooms in the QEUH required to comply with SHTM 2025, Part 2 of 4 Design considerations (June 2001), 10 ACH for treatment rooms and there should be a means of monitoring pressure. The commissioning procedures set out in CIBSE etc should be followed.

6.7 In accordance with the ERs[77], the isolation rooms required to comply with HBN 04 Supplement 1 which stated that an isolation suite (PPVL) should have 10 ACH and an ensuite isolation suite should have at least 10 ACH. The lobby to bedroom pressure should be 10 Pa, the bedroom to lobby nominally zero, and the ensuite to bedroom negative. The suite as a whole should be sealed, solid ceiling with sealed windows. An isolation suite should have an air leakage rate of no more than 1l/s of air per 1m3 of envelope volume and should have between 8 and 12 Pa between entry lobby and corridor. The patient's room should have 10 ACH. There should also be a monitor at the nurse station to indicate a failure of the supply or extract fan. Commissioning should be carried out.

6.8 Again, in accordance with the ERs[78], the isolation rooms in the QEUH required to comply with SHFN 30 'Infection control in the built environment: design and planning.' For negative pressure isolation rooms, there requires to be a readily visible monitor independent of the the air supply/extract supply. Commissioning should be carried out.

[75] **A32994127** – [Ventilation of Isolation Rooms], ITPD Volume 2 - Clause 8.2.15.7(c)
[76] **A32994127** – [NHS Mandatory Documentation], Table 2, ITPD Volume 2 - Clause 8.2.15.7(a)
[77] **A32994127** – [NHS Mandatory Documentation], Table 2, ITPD Volume 2 - Clause 5.1.2
[78] **A32994127** – [NHS Mandatory Documentation], Table 2, ITPD Volume 2 - Clause 5.1.2

6.9 Critical care areas and high dependency units (ITU/HDU) were not listed within the draft SHTM 03-01 (2009). Isolation rooms require HEPA filtration. The ACH for ITU/HDU is 10 ACH and for ward isolation rooms is the ACH set out in SHPN 4 (which is 10 ACH). An infectious disease isolation room should be 10 ACH and so should one for a neutropenic patient ward. In relation to pressure, it should be between 8 and 12 Pa for a ward isolation room, -5 Pa for a negative pressure room, and +10 Pa for ITU/HDU. There is no specified pressure for a general ward room. There should be alarms to monitor pressure differences. Commissioning and validation must be carried out.

6.10 SHTM 03-01 (2009) states that an infectious disease isolation unit and intensive treatment unit will usually have specialist ventilation requirements[79]. Table A1 of SHTM 03-01 (2009) states that an infectious disease isolation room should have 10 ACH and -5 Pa pressure while an intensive treatment unit (and high dependency unit) should have 10 ACH and +10 Pa pressure[80].

7. Deficiencies in Ward 4B Isolation Rooms

4B – BMT

Specification of Isolation Rooms

7.1 The original specification was for a 14 bed in-patient Haemato-oncology ward and comprised three documents[81]:

(i) The Board's COS for Haemato-oncology Ward; and

(ii) SHPN 054 – Facilities in Cancer Centres (2009); and

(iii) SHTM 03-01 Ventilation for Healthcare Premises (2009)

[79] **A33010783** - SHTM 03-01 (2009) - Paragraph 1.26
[80] **A33010783** - SHTM 03-01 (2009) - Page 142
[81] **A38030075** - Email between M Lockhart, A Rankin, G Geraldine, M Lockhart regarding QEUH Ward 4B Haemato -oncology - 25 November 2015

7.2 However ultimately the specification was changed to 24 isolation room when the change order was made on 19 June 2013[82].

What was deficient about isolation rooms at handover?

7.3 On 9 November 2012, Dr Inkster contacted Peter Hoffman to enquire about isolation rooms with lobbies as they seemed to have replaced plans for negative pressure rooms. Mr Hoffman explained that he suspected these rooms with lobbies were PPVL rooms in accordance with HBN 4 Supplement 1. He raised concerns that PPVL would allow air to either leak outwards or inwards towards the patient. Mr Hoffman was happier with the concept of negative pressure. He further commented that positive pressure without HEPA filtration was pointless[83].

7.4 Dr Inkster on two occasions referred the design and infection control teams to CDC guidance on specification[84]. On 19 June 2015, Professor Williams acknowledged that the adult BMT unit rooms would offer less protection than the previous unit at the Beatson[85].

7.5 On 29 June 2015, Dr Peters carried out a gap analysis between the adult BMT Unit and the Beatson specification, SHTM 03-01 and CDC Guidance. The following gaps were identified[86]:

- Corridor not HEPA filtered
- Air changes per hour – no information
- Positive pressure rooms – no information
- Ceilings in bedrooms and bathrooms not sealed.

[82] **A36372603** - Change Control Form dated 19 June 2013 - Scottish Hospitals Inquiry - Hearing Commencing 19 August 2024 - Bundle 16 - Ventilation PPP - Page 1699
[83] **A48375995** - Email from Peter Hoffman's email to Teresa Inkster Regarding Isolation Room Ventilation – 9 November 2012.
[84] **A32375944** - Letter from Teresa Inkster and Christine Peters to David Stewart - 09 November 2015
[85] **A40241907** - Email chain between Prof C Williams, J Hood, and Dr C Peters regarding transplant ventilation - 19 June to 1 July 2015.
[86] **A49388147 -** Emails between Dr T Inkster, D Loudon, M McColgan and J Armstrong - 15 to 16 June 2016

- No visual pressure indicators on rooms.
- No alarm system for pressure failure

7.6 By 1 July 2015 it was unclear if commissioning or validation had been carried out for the adult BMT unit[87]. On 23 July 2015, Professor Craig Williams sent a specification for the rebuild of the BMT unit to Mr Hoffman. The response raised a number of queries and concerns and that he suggested the involvement of Health Protection Scotland (HPS). It does not appear that any response was sent to Mr Hoffman by Professor Williams to any of his queries and concerns. The Inquiry Team has not seen any reply[88].

7.7 In July 2015, NHS GGC instructed a change to Level 4 for the installation of large fan motor and associated equipment and works by MPX which would result in 10-12 ACH, positive pressure room to corridor of 5-10 Pa, corridor to atrium of 2-3 Pa, solution to seal ceilings, and pressure monitoring solutions for rooms viewable from corridor for each room[89]. They also requested that digital pressure gauges be installed in 24 single bedrooms on Level 4[90].

7.8 In July 2015, upgrade works were undertaken in Ward 4B which resulted in some changes. The room pressure of 3-4 Pa was increased to approximately 5+ Pa. Bedrooms which had suspended ceilings were sealed by the use of plasterboard although the ensuites remained with suspended ceiling tiles. A pressure monitoring system was also installed.

7.9 Professor Jones noted in August 2015 that consistent advice had been that PPVL rooms were not appropriate for the protective isolation of severely immunocompromised patients[91].

[87] **A40241907** - Email chain between Prof C Williams, J Hood, and Dr C Peters regarding transplant ventilation - 19 June to 1 July 2015
[88] **A49387012** - Emails between T Inkster and C Williams regarding BMT - 10 to 11 November 2015
[89] **A36372656** - H29 – PMI 424 – Redesign AHU. - Scottish Hospitals Inquiry - Hearing Commencing 19 August 2024 - Bundle 16 - Ventilation PPP - Page 1799
[90] **A41683206** - PMI 430 QEUH HAEMATO ONCOLOGY WARD LEVEL 4 – 24 SINGLE ROOMS PRESSURE GAUGES. - Scottish Hospitals Inquiry - Hearing Commencing 19 August 2024 - Bundle 16 - Ventilation PPP - Page 1801
[91] **A49073232 -** Email chain from B Jones to T Inkster – 13 August 2015.

7.10 The 24 isolation rooms were deficient at handover as they did not achieve 5-10 Pa differential pressure, the ceilings were not sealed, and the ACH was only 6 rather than 10. By October 2015, upgrade works had been completed by MPX which included sealing the isolation rooms using MF plasterboard ceiling and sealing tiles with silicon[92]. Air permeability testing was carried out within the parameters set out in the SHPN 04-01 Supplement 1. The ventilation systems were uprated to achieve room differential pressures of between 5 to 10 Pa. The 24 isolation rooms were fitted with HEPA filtration in the supply diffusers. A digital differential pressure monitoring system was also installed.

7.11 The ICT lead in place at the time of the alterations to Ward 4B completed in October 2015, (which the Inquiry Team understands to be Professor Williams), was in the process of signing off the works. This did not happen due to a change in personnel[93].

7.12 In December 2015, an SBAR was issued which set out a number of the deficiencies within the adult BMT unit such as the need for 10 Pa positive pressure, HEPA filtration, 10 ACH, and sealed rooms[94]. On 19 January 2016, 10 ACH and 10 Pa was said to be unachievable. One alternative was proposed by Dr Inkster of HEPA filtration of the ward corridor air and sealing of the bathrooms which would then allow acceptance of reduced ACH and Pa. A feasibility study was planned to look at this option[95].

7.13 In March 2016, NHS GGC requested a programme of works to achieve HEPA filtered corridors, fully sealed bathrooms, room pressures of 2.5-8 ACH, 6 ACH prep room, 6 ACH entrance, air lock door at entrance to ward and exit door sealed[96].

[92] **A41683247** - QEUH – Ward 4B Upgrade Works – report by Brookfield Multiplex dated October 2015. - Scottish Hospitals Inquiry - Hearing Commencing 19 August 2024 - Bundle 20 - Documents referred to in the Expert Reports by Andrew Poplett and Allan Bennett - Page 1228
[93] **A49388148 -** Timetable of events in relation to adult BMT unit - Dr T Inkster
[94] **A38029602** - SBAR – Adult Bone Marrow Transplant – DRAFT – Version 2 - 02 December 2015
[95] **A49388147 -** Emails between Dr T Inkster, D Loudon, M McColgan and J Armstrong - 15 to 16 June 2016
[96] **A36372634** - Project Manager Instruction 471 – Ward 4B / Haemato -Oncology Ward - Alteration to board requirements

7.14 By May 2016, the major issues identified with Ward 4B were sub 10 ACH and non-HEPA filtered air in the ward corridor[97].

7.15 In September 2017, further upgrade works were undertaken that resulted in the ensuites within the ward becoming sealed by the use of plasterboard (the Inquiry Team understands to be partial implementation of a PMI issued by NHS GGC on 9 March 2016[98]).

7.16 In October 2017, an SBAR was issued relating to the adult BMT unit which set out the 2015 SBAR recommendations and noted that while upgrade works in the interim had implemented many of the recommendations, the unit still fell short on ACH (6 ACH rather than 10 ACH)[99].

7.17 In 2024, there were no HEPA filtered corridors and the ACH remained 6 rather than the desired 10 ACH[100].

Missing Air Lock

7.18 The scope of works relating to MPX's feasibility report PMI 475, included an entrance air lock to be created with interlocked doors through then current Interview Room (HOW-203)[101]. On 23 June 2016, ICT were not in a position to sign off the Adult BMT Unit as there were no solid ceilings in bathrooms, the ACH was not at the minimum of 10 ACH and the positive pressure not at 8-10 Pa[102].

[97] **A41683154** - Letter from A Parker, G McQuaker, D Irvine, I Novitzky-Basso, A Clark regarding BMT return to QEUH
[98] **A36372634** - Project Manager Instruction 471 – Ward 4B / Haemato -Oncology Ward - Alteration to board requirements
[99] **A38030914** - Email chain between A Rankin, P Hoffman regarding BMT SBAR - 26 October 2017
[100] **A47540479** - Provisional Position Paper 12 – Potentially Deficient Features of the ventilation system - Paragraph 6.108
[101] **A40241476** - Email chain between T Inkster, J Armstrong, M McColgan, and S Russell regarding Ward 4B alteration proposal - 25 April to 4 May 2016
[102] **A46157915** - Email from C Peters to T Inkster re Infection control handover - 25 July 2016.

7.19 On 30 June 2016, there was no air lock in Ward 4B. The Beatson BMT unit had an air lock[103]. On 28 November 2016, it was noted that there were to be four bedrooms with their own air lock lobby[104].

No Annual Verification

7.20 The Inquiry Team has been unable to locate annual verification information post handover including 2018/2019.

Current status of the isolation rooms?

7.21 On 5 June 2015, the BMT unit in Ward 4B did not have HEPA filters fitted[105]. On 6 May 2016, an SBAR was raised about the PPVL in Ward 4B amid concerns that the PPVL was not compliant with SHMT 03-01[106] (which the Inquiry Team understands was the draft 2009 version).

7.22 On 2 February 2017, a further SBAR was raised expressing concern about the suitability and safety of isolation rooms in Critical Care for patients with multi-drug resistant Tuberculosis ("MDRTB") and Middle East Respiratory Syndrome coronavirus ("MERS-CoV"). There were ten PPVL rooms in Critical Care at QEUH. Infectious diseases (ID) had access to two of these rooms for the isolation of patients with confirmed or suspected airborne infections. There were no negative pressure rooms in QEUH. The SBAR highlighted the two main recommendations of an HFS report issued in 2016 which were that PPVL rooms are not used for highly infectious patients and the isolation rooms in Critical Care be modified to the original design criteria (such as extracts in patient rooms and 10 ACH). It was assessed that the PPVL rooms should be rectified. Amongst the recommendations

[103] **A40241439** - Email chain between D Loudon, M McColgan, and A Parker regarding Ward 4B alteration proposal - 23 to 30 June 2016
[104] **A39465091** - Bone Marrow Transplant (BMT) Unit – Feasibility Study carried out by Currie & Brown - 28 November 2016.
[105] **A49387376 -** Email from C Williams to J Armstrong regarding BMT unit - 5 June 2015
[106] **A38759255** - SBAR re Infection Control and Patient Safety - 3 October 2017

were to obtain an opinion from HSE on the suitability of PPVL rooms for airborne infections, confirmed MDRTB patients to be transferred to negative pressure room in GRI and suspected MERS cases to go to Monklands DGH ID Unit.

7.23 An SBAR Action Plan issued in January 2019 shows 4 PPVL rooms (2 in Medical HDU, 1 in ITU, and 1 in Surgical ITU Unit 1) being converted to negative pressure rooms. The work was then ongoing and was to recommence in April 2019[107]. The works were completed by June 2021 as it is stated in the Clinical Care and Governance Paper that 7 PPVL rooms had been converted to negative pressure rooms[108]. The converted PPVL rooms are set out below:

RHC	Ward 2C	Room 6
RHC	CDU	Room 18
RHC	PICU	Room 5
QEUH	Medical HDU	Room 43
QEUH	Medical HDU	Room 44
QEUH	ITU 1	Room 24
QEUH	Surgical ITU Unit 1	Room 4

Intensive Care Unit (ICU)

Specification of Isolation Rooms

7.24 On 25 May 2009, it was noted that 10 isolation rooms with ante-rooms were designed for Critical Care (which was to include ICU and HDU). This appears to have been requested by clinicians as it stated “as per user request”[109].

7.25 The ICU was designed to have 20 beds in two pods of ten, 2 of which would be single rooms with gowning lobbies and the remaining 18 being single bedrooms with glass frontage. Clause 7.2 of the Critical Care COS notes that the Environmental and Services Requirements “should correspond to the relevant

[107] **A46157857** - Email from T Inkster to C Peters re SBAR Action Plan – Latest version – 24 September 2019
[108] **A38759230** - Clinical Care and Governance Paper - 8 June 2021
[109] **A49387498 -** Email from H Griffin to A Seabourne, P Moir, B Cowan regarding Isolation rooms, MDU and Renal Dialysis - 25 May 2009

SHPNs, HTMs and other technical guidance and the technical output specification for this project"[110].

7.26 The Adult Isolation Rooms COS noted that there were to be 10 negatively pressurised sealed rooms with ante-rooms for Critical Care (which includes ICU/Surgical and Medical HDU)[111].

Were there deficiencies in isolation rooms at handover?

7.27 On 4 September 2015, Ann Harkness stated that the isolation rooms tested in critical care had passed the full range of tests and that patient placement would be in the ICU area until the full test programme had been completed for medical HDU[112].

High Dependency Unit (HDU)

7.28 In May 2016, a SBAR noted that NHS GGC ID physicians at QEUH were expressing concern in relation to the suitability and safety of isolation rooms in critical care for patients with MDRTB and MERs-CoV. It was noted that there were ten PPVL rooms in Critical Care at the QEUH, but these were not negatively pressured as had been originally specified[113]. There were no negative pressure rooms in the QEUH. Due to these concerns, a report was instructed from HFS[114].

What was deficient about isolation rooms at handover?

7.29 There was an issue with the door not closing and the absence of a door handle in the negative pressure room in HDU. However, Professor Williams

[110] **A35761814** - Critical Care Clinical Output Specification
[111] **A35185320** - Adult Isolation Rooms requirements
[112] **A38694871 -** SBAR dated 26 April 2016 - Timeline ID SGUH - Scottish Hospitals Inquiry - Bundle of Documents for the Oral Hearing Commencing 12 June 2023 - Bundle 4 - NHS Greater Glasgow and Clyde: Situation, Background, Assessment, Recommendation (SBAR) Documentation
[113] **A36372525** - A13 – Clarification issued to bidders re' (undated).
[114] **A39465126** - SBAR Isolation Rooms Critical Care, Dr T Inkster - May 2016

confirmed that all negative pressure rooms had been passed for the specification of the build[115].

7.30 In August 2015, there was an issue with the negative pressure HDU isolation rooms in the QEUH and that they were not usable for a highly infectious pathogen at that time[116]. In October 2015, it was unclear if the 2 HDU negative pressure rooms had been passed by the infection control team[117].

Renal Ward

7.31 In 2009, the Renal ward was intended to have two positively pressured sealed rooms with negatively pressured ante-rooms[118].

Specification of Isolation Rooms

7.32 The QEUH Renal Ward COS stated that "two single rooms per ward will have associated gowning lobbies for infection control purposes (source and protection)[119]". The Inquiry Team understands that this is a reference to the PPVL rooms. The QEUH has three renal wards located in ward 4A[120], part of ward 4C[121], and ward 4D[122]. Since there are three wards, in terms of the COS, there ought to be six isolation rooms. There are only two rooms. It should also be noted that the 2 rooms per ward were to be positively pressured sealed rooms with negatively pressured ante-rooms located within the twenty bedded higher acuity ward[123].

What was deficient about isolation rooms at handover?

[115] **A32221764 -** Minutes of BICC, 30 November 2015. - Scottish Hospitals Inquiry - Hearing Commencing 24 April 2023 - Bundle 13 - Witness Statements - Page 268
[116] **A49073358** - Email chain from B Jones to C Peters – RE Negative pressure rooms in QEUH – 31 August 2015.
[117] **A46191398** - Email from D Bell to C Peters and others re MERS patient – 07 October 2015.
[118] **A36372543** - NHS GGC Infection Control Meeting - 18 May 2009 - Pages 1-2; **A36372525**, A13 – Clarification issued to bidders re' (undated).
[119] **A35762086** - NSGACL Renal NSG_iss1_rev. - Scottish Hospitals Inquiry - Hearing Commencing 19 August 2024 - Bundle 16 - Ventilation PPP - Paragraph 2.1.1, Page 1624; .
[120] **A44312662** - QEUH Adults Renal 4A Psuedonomonas Report Draft 1606. - Scottish Hospitals Inquiry - Hearing Commencing 19 August 2024 - Bundle 18 - Documents referred to in the expert report of Dr J.T. Walker - Volume 2 (of 2) - Page 1321
[121] **A40241808** - Email from C Peters to T Walsh and others – Meeting re Ventilation – 25 June 2015.
[122] **A41890251** - PAG Minute dated 6 February 2018 – VRE – Renal Wards QEUH. - Scottish Hospitals Inquiry - Hearing Commencing 19 August 2024 - Bundle 12 - QEUH Estates Team - Page 84
[123] **A35185320** - Adult Isolation Rooms requirements

7.33 There was an insufficient number of isolation rooms.

Infectious Diseases

Specification of Isolation Rooms

7.34 On 30 May 2015, adult patients moved to the QEUH[124]. There is no guidance specifying the number of negative pressure isolation rooms required for an ID ward. That would be a decision for clinicians. However, the Brownlee Unit at Gartnavel General Hospital (later moved to QEUH) had 4 negative pressure isolation rooms.

7.35 No COS or design specification exists for the transfer of the Brownlee Unit to the QEUH.

What was deficient about isolation rooms at handover?

7.36 On 29 January 2015, Professor Williams stated that Estates' view was that lobbied isolation rooms at the QEUH provided equivalent protection in relation to MDRTB[125].

7.37 In Table A1 of Appendix 2 of SHTM 03-01 (2009) there is specific provision made for ID isolation rooms. They should have an ACH of 10 and a pressure of -5 Pa.

7.38 At handover, all rooms in the ID Ward had the same ACH as the general wards (2.5 ACH). The pressure was "0 or slightly -ve relative to the corridor" rather than the required -5 Pa.

[124] **A32221627** - Minutes of the BICC 18.05.2015 - Scottish Hospitals Inquiry - Hearing Commencing 24 April 2023 - Bundle 13 - Witness Statements - Page 243
[125] **A49073341** - Email chain from E Peters to C Peters – High Risk airborne infections – 22 July 2015.

7.39 The General Adult Wards COS states that "1 room per ward will be used for isolation purposes and will have an associated gowning lobby[126]". If the ID Ward was to be treated as a Generic Ward, then it would be expected to have one isolation room. It has none.

7.40 At handover, Professor Williams stated the rooms in IDU were compliant[127]. Subsequently, on 27 July 2015, Professor Williams stated that all ID rooms had been built to specification and there was no risk to patients[128].

7.41 The commissioning of the ventilation plantrooms serving level 5 was undertaken in late 2014[129] albeit some of the commissioning reports were not signed by a witness. The Inquiry Team has not found any evidence to suggest that the ventilation system serving Level 5 was validated in the five months between the commissioning and the hospital opening to patients in May 2015. This lack of validation is covered in more detail in PPP 12.

What is the current status of the isolation rooms?

7.42 On 27 January 2015, concerns were raised that the PPVL were not fit for purpose as the patient room was not under negative pressure and would be unable to properly isolate patients with suspected MERS etc[130].

[126] **A35761946** - New South Glasgow Hospital, Clinical Output Specification, Generic Adult Wards - Scottish Hospitals Inquiry - Hearing Commencing 19 August 2024 - Bundle 16 - Ventilation PPP - Page 1655
[127] **A32221794** - Minutes of BICC, 26 January 2015 - Scottish Hospitals Inquiry - Hearing Commencing 24 April 2023 - Bundle 13 - Witness Statements - Page 229
[128] **A32221767** - Minutes of BICC, 27 July 2015. - Scottish Hospitals Inquiry - Hearing Commencing 24 April 2023 - Bundle 13 - Witness Statements - Page 256
[129] Ward 5A, **A32954762** - 122 - AHU 04 SUPPLY (4TH TO 7TH FLOOR); **A32954806** - 122 - AHU 04 DIRTY EXTRACT (4TH TO 7TH FLOOR); **A32954760** - 122 - AHU 05 SUPPLY (4TH TO 7TH FLOOR WARDS) REPORT**;** **A32954763** - 122 - AHU 05 DIRTY EXTRACT (4TH TO 7TH FLOOR WARDS) REPORT**;** **A32954766** - 122 - AHU 06 SUPPLY (4TH TO 7TH FLOOR WARDS) REPORT (AWAITING SCHEMS)**;** **A32954768** - 122 - AHU 06 CLEAN EXTRACT (4TH TO 7TH FLOOR); Ward 5B, **A32954556** - 121 - AHU 04 SUPPLY (5TH TO 7TH FLOOR WARDS)**;** **A32954552** - 121 - AHU 04 EXTRACT (5TH & 7TH FLOOR WARDS)**;** **A32954535** - 121 - AHU 05 SUPPLY (5TH TO 7TH FLOOR WARDS)**;** **A32954557** - 121 - AHU 05 EXTRACT (5TH & 7TH FLOOR WARDS)**;** **A32954527** - 121 - AHU 06 SUPPLY REPORT**;** **A32954532** - 121 - AHU 06 EXTRACT REPORT; Ward 5C, **A32955621** - 124 - 7EF02 (LEVELS 4,5,6 & 7) REPORT**;** **A32955593** - 124 - AHU 04 SUPPLY REPORT**;** **A32955592** - 124 - AHU 04 DIRTY EXTRACT REPORT**;** **A32955598** - 124 - AHU 05 DIRTY EXTRACT REPORT**;** **A32955606** - 124 - AHU 06 SUPPLY REPORT**;** **A32955608** - 124 - AHU 06 CLEAN EXTRACT REPORT; Ward 5D, **A32955085** - 123 - AHU 04 SUPPLY (4TH TO 7TH FLOOR WARDS) REPORT**;** **A32955093** - 123 - AHU 04 DIRTY EXTRACT (4TH TO 7TH FLOOR WARDS) REPORT**;** **A32955082** - 123 - AHU 05 SUPPLY (4TH TO 7TH FLOOR WARDS)**;** **A32955079** - 123 - AHU 05 DIRTY EXTRACT (4TH TO 7TH FLOOR WARDS) **;** **A32955112** - 123 - AHU 06 SUPPLY (4TH TO 7TH FLOOR WARDS)**;** **A32955119** - 123 - AHU 06 EXTRACT (4TH TO 7TH FLOOR WARDS) REPORT
[130] **A49073341** - Email chain from E Peters to C Peters - High risk airborne infections - 22 July 2015

7.43 On 25 June 2015, Dr Christine Peters emailed Ian Powrie (Estates) a list of notes from a meeting relating to ventilation. The email noted *inter alia*:

- None of the PPVL rooms have HEPA filter supply.
- None of the PPVL rooms have been leak tested.
- There is an extract in the bedroom (in roof) as well as in the toilet in the lobbied suites.
- The lobbied suites are 2 on the Renal 4C, 8 on Critical Care.
- Most of the rooms on 5B Haemato-oncology ward (where BMT patients are currently housed) have HEPA supply – except 3 which we need to have identified. There is no HEPA supply to the corridor, or the prep room on this ward.
- The 5B rooms are not designed to be positive pressure rooms to 10 Pa differential to the corridor and the air exchange rate we think is 10 ph.

7.44 On 13 June 2016, HFS and NHS GGC met to discuss the scope of the Isolation Rooms Report 2016 (QEUH). The main design guidance documents current at the time of design for isolation rooms were SHPN 04 Supplement 1 dated September 2008 and HBN 04-01 Supplement 1 dated 2005. However, these did not describe the specialist facilities required for ID units or on wards where severely immune-compromised patients are nursed.

7.45 On 3 December 2018, Ward 5C was tested and approved following works to make it negative pressure (corridor to bedroom[131]). On 23 December 2018,

[131] **A41790834** - Ward +4C & -5C Pressure change report – H&V Commissioning (14 December 2018). - Scottish Hospitals Inquiry - Hearing Commencing 19 August 2024 - Bundle 20 - Documents referred to in the Expert Reports by Andrew Poplett and Allan Bennett - Page 1515

Wards 5D and 7D were tested and approved following works to make the neutral pressure (bedrooms to corridor) a negative pressure (corridor to bedroom)[132].

7.46 It is unclear to the Inquiry Team what works were instructed or carried out. In June 2019, the conversion works were signed off by Dr Inkster who confirmed that all rooms met requirements for air pressure and air changes. She also confirmed they had HEPA filtered extract[133]. The Inquiry Team have been unable to locate the reports signed off by Dr Inkster. Details of these rooms relating to air pressure, air changes and HEPA filter location (i.e. freestanding or within ceiling diffuser) cannot be confirmed.

8. Review of Existing Facilities

‘The Beatson’

8.1 In 2007, the Beatson Oncology Centre, which was by that time spread over 4 hospitals (Western Infirmary, Gartnavel General Hospital, Glasgow Royal Infirmary, and Stobhill Hospital) moved to a newly built hospital, The Beatson West of Scotland Cancer Centre (“BWoSCC”) in the grounds of the Gartnavel Campus. The BWoSCC is the lead centre for delivery of non-surgical cancer care for the West of Scotland.

8.2 The adult Bone Marrow Transplant service (“BMT”) moved to the BWoSCC in 2008. The adult BMT unit was split across two wards, with 10 rooms in the transplant unit (B8) and 10 beds in ward B9. The Inquiry Team understands that these wards had mostly single rooms, though there may have been a couple of twin rooms.

8.3 In 2008, advice was sought from Dr Hood in relation to suitable ventilation for the proposed haemato-oncology ward at QEUH. Dr Hood’s advice was

[132] **A44943716** - 2018-12-23 – Ward 5D and 7D Pressure change report – H&V Commissioning (3 December 2018). - Scottish Hospitals Inquiry - Hearing Commencing 19 August 2024 - Bundle 20 - Documents referred to in the Expert Reports by Andrew Poplett and Allan Bennett - Page 1521
[133] **A46157873** - Email chain – Infectious Patient Placement (17 June 2019 – 15 January 2020) - Scottish Hospitals Inquiry - Hearing Commencing 19 August 2024 - Bundle 20 - Documents referred to in the Expert Reports by Andrew Poplett and Allan Bennett - Page 1530

incorporated into the COS for that ward. A clarification relating to isolation rooms for the ward was later provided to bidders during competitive dialogue[134].

Beatson Isolation Room Standards

8.4 In May 2013, it was known at the time of the decision to move the adult BMT unit to the QEUH that the corridor would not be HEPA filtered, but it was expected that the rooms would be of an acceptable standard for highly immunocompromised patients with appropriate HEPA filtration, room pressures and ACH[135]. On 19 June 2013, a change request form was submitted to enable Ward 4B (the Haemato-oncology ward) to accommodate the BMT unit[136]. On 9 July 2013 the decision was approved by the Chief Operating Officer.

8.5 The specification within the change request form was used by MPX and NHS GGC to develop design detail utilising the RDD process[137]. The NHS GGC Board confirmed proposals in Compensation Event No. 51, dated 2 October 2013[138]. However, this only instructed that an additional number of rooms should be built to the same specification as those in the haemato-oncology ward. Accordingly, a design was concluded for the ward that did not meet all the requirements for its intended use[139].

8.6 It appears that the decision to make this change did not consider that Ward 4B retained the same (approximately 2.5-3 ACH) ventilation rate as the rest of the hospital.

8.7 The original specification for the BMT unit at Gartnavel included HEPA filtration, positive pressure (+5-10 Pa), clear visual display pressure monitor, 10-12 ACH, and two positive pressure isolation rooms with negative pressure ante

[134] **A36372525** - A13 – Clarification issued to bidders re' (undated).
[135] **A40241439** - Email chain between D Loudon, M McColgan, and A Parker regarding Ward 4B alteration proposal - 23 to 30 June 2016
[136] **A36372603 -** Change Control Form dated 19 June 2013. - Scottish Hospitals Inquiry - Hearing Commencing 19 August 2024 - Bundle 16 - Ventilation PPP - Page 1699
[137] **A36372565** - PMI 228. - Scottish Hospitals Inquiry - Hearing Commencing 19 August 2024 - Bundle 16 - Ventilation PPP - Page 1697
[138] **A36372655** - Compensation Event issued by the Deputy Project Director to Brookfield on October 2013 for inclusion of HEPA in level 4 zones 512, 513, and 514 - 2 October 2013
[139] **A36372554** - Briefing Note on Design of BMT unit - 9 July 2015.

room[140].The Inquiry Team understands the ventilation was designed with assistance from top international experts.

8.8 An email exchange from summer 2015 suggests the following ventilation provision was in place at the Beatson:

- HEPA filtration for high risk patients.
- Positive pressure in each room, 5-10 Pascals in relation to corridor.
- Air exchanges required to be >12ph
- Sealed room (0.5 sq ft leakage)
- Clean to dirty airflow
- Backup system in case of failure/need to shut down maintain system
- Water resistant paint
- Fungicidal plasterboard in bathroom and toilet
- A clear digital read out of the pressure difference across the door (not a magnahelix guage)
- Particle counts in rooms when commissioned, cleaned and empty of people should be 1000 particles of <0.5 microns per cubic foot. Good ones should be 100-200 or less[141].

8.9 On 7 August 2016, the proposed Ward 4B remedial works attached report confirmed that the Beatson had[142]:

- HEPA filtered rooms
- HEPA filtered corridors

[140] **A49387013 -** BMT Original Specification - Gartnavel site - Dr John Hood
[141] **A40241907** - Email chain between Prof C Williams, J Hood, and Dr C Peters regarding transplant ventilation - 19 June to 1 July 2015
[142] **A40241439** - Email chain between D Loudon, M McColgan, and A Parker regarding Ward 4B alteration proposal - 23 to 30 June 2016.

- 10 ACH
- 10 Pa
- No sealed rooms
- Air lock entrance to ward
- No air pressure monitoring system
- A back up plan.
- Rooms with anteroom at negative pressure for infectious BMT patients.

Beatson Moves

8.10 In August 2014, it was confirmed by Professor Williams that the adult BMT unit would sit beside the Renal Unit[143].

8.11 On 6 June 2015, the adult BMT unit in the Beatson Oncology Unit transferred to Ward 4B in the QEUH[144]. However, on 8 July 2015, the adult patients returned to Gartnavel, as the adult BMT unit was not built to the required specification. It was identified that the air quality was extremely poor in the new adult BMT unit[145].

8.12 Not until 30 June 2018, following upgrade works, did adult patients return to Ward 4B in the QEUH.

‘The Brownlee’

[143] **A40247643** - SMT Minutes, 27 August 2014. - Scottish Hospitals Inquiry - Hearing Commencing 24 April 2023 - Bundle 13 - Witness Statements - Page 484
[144] **A41683168** - BMT Briefing and Overview Note by Gary Jenkins dated 06 July 2015. - Scottish Hospitals Inquiry - Hearing Commencing 24 April 2023 - Bundle 13 - Witness Statements - Page 840
[145] **A40241439** - Email chain between D Loudon, M McColgan, and A Parker regarding Ward 4B alteration proposal - 23 to 30 June 2016

8.13 The Brownlee Unit at Gartnavel Hospital was an Infectious Disease Unit ("IDU") known to have treated inpatients suffering from HIV/AIDS and multiple other infectious and tropical diseases including tuberculosis. The IDU treated 2 definite cases of High Consequence Infectious Disease (Crimean Congo Haemorrhagic Fever in 2012 and Ebola in 2014).

8.14 The IDU had 30 rooms. 3 rooms accommodated 2 people and there were 27 single rooms, which included 4 isolation suites. NHS GGC cannot currently confirm what type of isolation rooms these were (i.e. positive or negative pressure) or details of the specialist ventilation requirements[146]. However, Dr Inkster has stated that 4 isolation rooms were negative pressure rooms[147].

8.15 Plans to move the Brownlee (and the Beatson) were already known in early July 2014[148]. The decision appears to have been made in July 2014 by the Department of Emergency Care and Medical Specialties (ECMS)[149], a department of NHS GGC. Part of the rationale was to gain proximity to state-of-the-art intensive care and other specialties at QEUH[150]. Generic bedrooms were mechanically ventilated with pressure in the rooms negative to the corridors. There were no lobbied bedrooms in the QEUH and this was agreed with Microbiology/ICT involvement. The Brownlee move had not featured in the original hospital planning. There was no IPC advice in relation to the transfer of the Brownlee Unit[151].

8.16 In August 2014, Professor Williams stated that the Brownlee would be transferred to the SGH (QEUH) despite not being part of the initial project plan. The Brownlee isolation rooms would sit in Critical Care[152].

[146] **A48090552** - GGC response to RFI - 20 March 2024.
[147] **A46510067** - Dr Inkster's Draft Statement - Paragraph 37.
[148] **A49386769 -** Emails between F McCluskey, S McNamee, C Williams regarding Highly Infectious patients in the NSGH and other issues - 11 August 2014
[149] **A49386769** - Emails between F McCluskey, S McNamee, C Williams regarding Highly Infectious patients in the NSGH and other issues - 11 August 2014
[150] **A49393871 -** SBAR - Timeline re correspondence regarding the move of the ID unit to the QEUH - dated 26 April 2016
[151] **A49386767 -** Email chain regarding Lobbied rooms in nSGH - 22 December 2014 to 14 January 2015
[152] **A40247643** - SMT Minutes, 27 August 2014. - Scottish Hospitals Inquiry - Hearing Commencing 24 April 2023 - Bundle 13 - Witness Statements - Page 484

8.17 By 14 January 2015, there were still doubts about the suitability of the lobbied rooms and Professor Williams commented on how this would impact the move of the ID unit from Gartnavel to QEUH[153].

8.18 In February 2015, Professor Williams reported that concerns had been raised by clinicians regarding the anterooms but that they seemed happy with the rooms now[154].

Why was the Brownlee moved?

8.19 The Inquiry Team have not been able to locate a formal record of the decision to move the Brownlee to the QEUH. Accordingly, it is not clear:

(i) Who made the decision and why;

(ii) Whether the move was risk assessed;

8.20 At handover in January 2015, the services being provided in the four generic wards on level 5 were:

Ward 5A	Diabetes
Ward 5B	Diabetes
Ward 5C	Communicable Diseases
Ward 5D	General Medical/ID Team

8.21 It appears the risk of moving the IDU set against the risk of not moving was assessed[155] and specifically whether the positive pressure isolations rooms ("PPVL") would be suitable[156].

[153] **A49386766 -** Emails between F McCluskey and C Williams regarding Lobbied rooms in nSGH - 20 August 2014
[154] **A40247585** - SMT Minutes - 25 February 2015.
[155] **A49386767 -** Email chain regarding Lobbied rooms in nSGH - 22 December 2014 to 14 January 2015; **A38694871** - SBAR dated 26 April 2016 - Timeline ID SGUH - Scottish Hospitals Inquiry - Bundle of Documents for the Oral Hearing Commencing 12 June 2023 - Bundle 4 - NHS Greater Glasgow and Clyde: Situation, Background, Assessment, Recommendation (SBAR) Documentation
[156] **A49386767 -** Email chain regarding Lobbied rooms in nSGH - 22 December 2014 to 14 January 2015

8.22 The Inquiry Team understands that the IDU was relocated to QEUH in wards 5C and 5D in 2015 without any modifications being instructed to the general ventilation system. The IDU team raised concerns about the move; specifically in relation to the number of lobbied isolation rooms at the QEUH and whether these provided the negative pressure required to treat certain infectious diseases[157].

8.23 The IDU team were given assurances that in addition to wards 5C and 5D, they would have exclusive access to two isolation rooms in Critical Care. This was described as a "deal breaker"[158]. No COS was provided for the IDU[159].

8.24 The rooms located in Critical Care were PPVL. Wallace Whittle had confirmed that the isolation rooms throughout the QEUH had been designed in line with SHPN 04 Supplement 1 and that they saw no reason why the isolation rooms could not be used under the previously issued NHS guidance. Professor Williams raised concerns over the exclusion in SHPN 04 Supplement 1 which stated: "This Supplement does not describe the specialist facilities required in infectious disease units or on wards where severely immuno-compromised patients are nursed"[160]. On 26 January 2015, Professor Williams reported to the BICC that "in relation to the MDRTB Regulations the rooms in IDU are compliant"[161].

8.25 At handover, there were only PPVL rooms in the QEUH[162]. In May 2016, ID clinicians raised grave concerns that the new building was not a fit or safe environment to manage dangerous pathogens[163]. Specific concerns raised were that the isolation rooms were not appropriate for isolating infectious diseases due to engineering and lack of alarm systems. There had been confusion among ID clinicians and the project team as to whether negative pressure isolation rooms

[157] **A49386769 -** Emails between F McCluskey, S McNamee, C Williams regarding Highly Infectious patients in the NSGH and other issues - 11 August 2014
[158] **A49393871 -** SBAR - Timeline re correspondence regarding the move of the ID unit to the QEUH - dated 26 April 2016
[159] **A48090552** - GGC response to RFI - 20 March 2024. – Paragraph 6-7
[160] **A49386767 -** Email chain regarding Lobbied rooms in nSGH - 22 December 2014 to 14 January 2015
[161] **A32221794** - Minutes of BICC, dated 26 January 2015 - Scottish Hospitals Inquiry - Hearing Commencing 24 April 2023 - Bundle 13 - Witness Statements - Page 229, Paragraph 4.5
[162] **A42463033** - NHS GGC SBAR Bundle – page 85, GGC Response to s.21 dated 14 July 2023. - Scottish Hospitals Inquiry - Bundle of Documents for the Oral Hearing Commencing 12 June 2023 - Bundle 4 - NHS Greater Glasgow and Clyde: Situation, Background, Assessment, Recommendation (SBAR) Documentation - Page 49
[163] **163. A49393871** - SBAR - Timeline re correspondence regarding the move of the ID unit to the QEUH - dated 26 April 2016

had been promised in 2014 or two rooms which offered “the same level of isolation as those in Brownlee”[164].

8.26 Dr Inkster’s view was that NHS guidance was inconclusive on whether PPVL rooms were safe enough to manage high consequence airborne infections. She requested an independent review of the isolation rooms by Health Facilities Scotland (“HFS”) with an opinion on their appropriateness for isolating infectious disease[165]. HFS reported that isolation rooms at QEUH did not in some instances meet the requirements of guidance but as they did not have air change rate information, they were unable to provide a comprehensive view. HFS recommended that patients should not be cared for in the PPVL rooms (either with or without ensuites)[166].

8.27 In May 2016, Dr Inkster noted that air change rates throughout the hospital had been reduced from the expected 6 ACH to 3 ACH including ‘high risk areas’ such as IDU, which would not normally have infection control sign off[167].

8.28 A temporary patient placement strategy was established to manage risks to patients and staff while an engineering solution was found to convert some of the Critical Care isolation rooms to negative pressure. Patients with infectious disease of high consequence (such as TB) were to be geographically separated from immunosuppressed patients with infection (largely those with HIV) in ward 5C and 5D, respectively[168].

8.29 Operational measures were to be implemented in these wards which included the use of PPE and a ‘2-hour rule’. Given reduced air changes, two hours

[164] **A39465086** - Record of correspondence regarding IPC concern over air change rates (2016-2020) - Scottish Hospitals Inquiry - Hearing Commencing 19 August 2024 - Bundle 20 - Documents referred to in the Expert Reports by Andrew Poplett and Allan Bennett - Page 1511 - 1512
[165] **A32310953** - SBARs; Air changes, Isolation rooms, Air sampling, Airborne infection, Endoscopy facilities, ward 4C, Ward 6A environment
[166] **A32310951** - QEUH Isolation Rooms Report 2016 – Ian Storrar, HFS - Hearing Commencing 26 February 2024 - Bundle 13 - Miscellaneous - Volume 8 - Page 601
[167] **A39465086** - Record of correspondence regarding IPC concern over air change rates (2016-2020) - Scottish Hospitals Inquiry - Hearing Commencing 19 August 2024 - Bundle 20 - Documents referred to in the Expert Reports by Andrew Poplett and Allan Bennett - Page 1497
[168] **A39465086** - Record of correspondence regarding IPC concern over air change rates (2016-2020) - Scottish Hospitals Inquiry - Hearing Commencing 19 August 2024 - Bundle 20 - Documents referred to in the Expert Reports by Andrew Poplett and Allan Bennett - Page 1510

had to be left before non-essential personnel could enter a room after aerosol generating procedures. Patients with MDRTB (Multiple Drug-Resistant Tuberculosis) or MERS (Middle East Respiratory Syndrome) would be transferred out of the QEUH to Monklands (NHS Lanarkshire) or the Glasgow Royal Infirmary. This 'temporary' patient placement strategy was still in place by the end of 2018 because the engineering solution for the negative pressure rooms on the 1st floor had been problematic and the work was suspended[169].

8.30 In April 2018, plans for converting PPVL rooms to negative pressure rooms were signed off[170].

8.31 In November 2018, following the discovery of issues in wards 2A and 2B of the RHC, Dr Inkster carried out pressure checks of other high risk wards. The biggest concern was the readings from 5C and 5D (the IDU)[171].

8.32 Tests had indicated neutral to positive pressure in rooms where TB patients were being cared for, thus potentially spreading pathogens into the corridor and other rooms. In rooms where immunocompromised HIV patients were being cared for neutral to slightly negative pressure was detected, thus potentially sucking pathogens into these rooms from the corridors[172].

8.33 Dr Inkster reported these findings to the NHS GGC Head of Health and Safety noting "My concern at the moment relates to the potential for staff/patients to have been exposed in 5D…"[173].

[169] **A38694865** - SBAR dated 27 June 2017 – Mycobacterium Abscessus and Cystic Fibrosis cohort - Scottish Hospitals Inquiry - Bundle of Documents for the Oral Hearing Commencing 12 June 2023 - Bundle 4 - NHS Greater Glasgow and Clyde: Situation, Background, Assessment, Recommendation (SBAR) Documentation - Page 99
[170] **A38759215** - AICC Meeting Minutes, 27 April 2018. - Scottish Hospitals Inquiry - Hearing Commencing 24 April 2023 - Bundle 13 - Witness Statements - Page 11
[171] **A39465086** - Record of correspondence regarding IPC concern over air change rates (2016-2020) - Scottish Hospitals Inquiry - Hearing Commencing 19 August 2024 - Bundle 20 - Documents referred to in the Expert Reports by Andrew Poplett and Allan Bennett - Page 1504
[172] **A39465086** - Record of correspondence regarding IPC concern over air change rates (2016-2020) - Scottish Hospitals Inquiry - Hearing Commencing 19 August 2024 - Bundle 20 - Documents referred to in the Expert Reports by Andrew Poplett and Allan Bennett - Page 1510
[173] **A39465086** - Record of correspondence regarding IPC concern over air change rates (2016-2020) - Scottish Hospitals Inquiry - Hearing Commencing 19 August 2024 - Bundle 20 - Documents referred to in the Expert Reports by Andrew Poplett and Allan Bennett - Page 1517

8.34 By late December 2018, adjustments had been made to the ventilation in wards 5C and 5D. H&V Commissioning verified that all rooms had achieved a notionally negative pressure. The report noted that "the retro fit of the door drop down seals would help with this control and stabilise pressures, as fitted on ward 4B[174].

8.35 By January 2019, a plan had been developed to convert seven PPVL isolation rooms in the QEUH to negative pressure isolation rooms. Four of the rooms identified for conversion were in the adult hospital and three were in the children's hospital[175].

8.36 In June 2019, IPC signed off three of the negative pressure isolation rooms in ITU/HDU for use by the ID team, noting that one did not have an ensuite[176].

8.37 By January 2020, a fourth isolation room in Critical Care had been converted to negative pressure. In May 2022, Cundall were appointed to assess whether the existing Air Handling Units (AHUs) located within plant room 124 (AHU 04 & AHU 05) had any additional capacity to increase the air change rate in wards 4C, 5C, 6C, and 7C.

8.38 Cundall's remit was to review the existing plant, highlight the associated works required to the existing services and list any additional equipment needed to achieve increased ventilation rates. A summary of their findings included[177]:

- The ventilation air change rates for the single bedrooms within wards 4C,

[174] **A39465086** - Record of correspondence regarding IPC concern over air change rates (2016-2020) - Scottish Hospitals Inquiry - Hearing Commencing 19 August 2024 - Bundle 20 - Documents referred to in the Expert Reports by Andrew Poplett and Allan Bennett - Page 1513; **A41790834** - Ward +4C & -5C Pressure change report – H&V Commissioning (14 December 2018). - Scottish Hospitals Inquiry - Hearing Commencing 19 August 2024 - Bundle 20 - Documents referred to in the Expert Reports by Andrew Poplett and Allan Bennett - Page 1515
[175] **A38759222** - SBAR – Multiple Wards – Action Plan - January 2019
[176] **A46157873** - Email chain – Infectious Patient Placement (17 June 2019 – 15 January 2020) - Scottish Hospitals Inquiry - Hearing Commencing 19 August 2024 - Bundle 20 - Documents referred to in the Expert Reports by Andrew Poplett and Allan Bennett - Page 1534
[177] **A41791368** - Cundall proposal – QEUH 4, 5, 6, & 7C Ventilation Report (20 May 2022). - Scottish Hospitals Inquiry - Hearing Commencing 19 August 2024 - Bundle 20 - Documents referred to in the Expert Reports by Andrew Poplett and Allan Bennett - Page 1434

5C, 6C, and 7C were found to be between 2.7 and 3.2 ACH.

- The single bedrooms and associated en-suites were commissioned to operate under a negative pressure in relation to the adjacent circulation space.

- The supply and extract distribution ducts within the risers and ceiling voids were inadequately sized to facilitate the required air volumes needed to achieve the single bedrooms 6 ACH.

- The maximum fresh air permitted through the Swegon Parasol ceiling terminals was significantly lower than what was required to achieve the required 6 ACH within the single bedrooms.

8.39 The proposed works for ward 5C have not been approved. NHS GGC have confirmed to the Inquiry that no physical changes have, to date, been made to the ventilation system serving the IDU since handover. It was only noted in 2020 by NHS GGC that there were capacity issues with the AHUs in the ventilation system.

8.40 The Inquiry Team has found no evidence that the performance of the ventilation system was validated before the QEUH opened in May 2015.

8.41 Some elements of the original design brief said to be signed off by representatives from IPCT during preferred bidder discussions were questioned by successive IPCT representatives when the hospital was operational. For example, the suitability of PPVL isolation rooms for infectious diseases was questioned in November 2012[178].

8.42 Concerns had been raised in 2014 over the proposed Brownlee Unit move to QEUH[179]. Once operational,

- Two negative pressure isolation rooms in critical care did not provide

[178] **A48375992** - Email from Jackie Stewart to Sandra McNamee Regarding isolation Rooms - 14 November 2012
[179] **A38694871 -** SBAR dated 26 April 2016 - Timeline ID SGUH - Scottish Hospitals Inquiry - Bundle of Documents for the Oral Hearing Commencing 12 June 2023 - Bundle 4 - NHS Greater Glasgow and Clyde: Situation, Background, Assessment, Recommendation (SBAR) Documentation

sufficient capacity for ID patients. On-call IPC consultants were faced with difficult decisions on the placement of highly infectious patients, without access to the most up to date information on the availability of negative pressure isolation rooms[180].

- Critical care nurses were charged with the care of ID patients but did not have the specialist knowledge and experience of an ID nurse. Specialist PPE kit was not available on the ward and had to be brought down from ward 5C[181].

8.43 Other than the following exceptions:

(i) Adjustments to the pressure regime / rebalancing work in December 2018[182].

(ii) Upgrades to the filters in the AHUs to improve air quality in March 2019[183].

to date, no physical changes have been made to the ventilation units serving wards 5C and 5D since handover on 26 January 2015[184].

8.44 The IDU at QEUH currently:

Is achieving air change rates between 2.7 ACH and 3.2 ACH**[185]**.

[180] **A49073341** - Email chain from E Peters to C Peters - High risk airborne infections - 22 July 2015
[181] **A46191399** - Email from C Peters to I Powrie re 5C Infectious diseases Unit – 18 December 2015. - Scottish Hospitals Inquiry - Hearing Commencing 19 August 2024 - Bundle 12 - QEUH Estates Team - Page 743
[182] **A39465086** - air changes - Scottish Hospitals Inquiry - Hearing Commencing 19 August 2024 - Bundle 20 - Documents referred to in the Expert Reports by Andrew Poplett and Allan Bennett - Page 1511
[183] Filter upgrade was from F7 to F9. There is currently no HEPA filtration in wards 5C and 5D. **A44943543** - 01 Physical changes Levels 4, 5 & 7 – NHSGGC response to s.21 No.18 (21 August 2023).
[184] **A44943543** - 01 Physical changes Levels 4, 5 & 7 – NHSGGC response to s.21 No.18 (21 August 2023). - Scottish Hospitals Inquiry - Hearing Commencing 19 August 2024 - Bundle 20 - Documents referred to in the Expert Reports by Andrew Poplett and Allan Bennett - Page 8
[185] **A41791368**- Cundall proposal – QEUH 4, 5, 6, & 7C Ventilation Report (20 May 2022). - Scottish Hospitals Inquiry - Hearing Commencing 19 August 2024 - Bundle 20 - Documents referred to in the Expert Reports by Andrew Poplett and Allan Bennett - Page 1434

Is achieving a notionally negative pressure regime (from bedroom to corridor) ranging from 0 to -3.5Pa[186]. Is being served by three AHUs operating at full capacity. Is not HEPA filtered. Does not have sealed rooms or doors.

Does not have digital pressure monitoring and alarm systems.

Has access to three negative pressure isolation rooms with ensuites in QEUH critical care unit.

Pentamidine Room

8.45 The original room data sheet for the Pentamidine room had balanced pressure to the corridor. A project manager's instruction (PMI) was issued in December 2013 to change the room to negative pressure to corridor. The Haemato-oncology ward required to have a negatively pressured treatment room for administration of pentamidine inhalations[187]. On 9 December 2013, it was said that the pentamidine room was negatively pressured, but it was subsequently confirmed this had not been achieved[188].

8.46 It required to be at negative pressure (-1 and -2) but post-handover it had positive pressure. Even -3 was not reliable[189].

8.47 On 22 July 2015, MPX confirmed that the pentamidine room was achieving 10 ACH and was under negative pressure of -1.5 Pa. They proposed no further

[186] **A44943716** - 2018-12-23 – Ward 5D and 7D Pressure change report – H&V Commissioning (3 December 2018). - Scottish Hospitals Inquiry - Hearing Commencing 19 August 2024 - Bundle 20 - Documents referred to in the Expert Reports by Andrew Poplett and Allan Bennett - Page 1521
[187] **A35185320** - Adult Isolation Rooms requirements
[188] **A43502680** - "BMT Document" – from Craig Williams to Jennifer Armstrong that considers the specification and identifies deficiencies with the BMT Unit. - Scottish Hospitals Inquiry - Hearing Commencing 19 August 2024 - Bundle 20 - Documents referred to in the Expert Reports by Andrew Poplett and Allan Bennett - Page 13
[189] **A39465105** - Email between P Hoffman, A Rankin, T Inkster, C Williams regarding BMT SBAR 2015 dated 21 December 2015

works[190]. On 29 July 2015, Peter Moir confirmed to Professor Williams and others that the ventilation system had been adjusted to achieve -1.5 Pa and 10 ACH[191].

8.48 In December 2015, microbiologists recorded that the Pentamidine treatment room was showing a positive pressure (2.5 Pa) from room to corridor[192]. This was a health and safety issue[193].

8.49 In September 2017, upgrade works in Ward 4B included validation of the pentamidine room[194]. In November 2017, the pentamidine room's ACH was recorded to be 8.7 ACH[195].

Respiratory Ward (Level 7)

8.50 The Respiratory Ward was to have three negatively pressured sealed rooms (without ante rooms) located together[196]. There were no lobbied rooms in the adult tower of the hospital with the only lobbied rooms within the adult hospital being in ITU/HDU[197]. There were no negatively pressured rooms.

8.51 The Respiratory Ward required to have 10 ACH and +10 Pa in accordance with SHTM 03-01 (2009) on the Inquiry Team's understanding that such a ward fell within ITU/HDU category in Table A1.

Endoscopy Rooms

8.52 It is noted in SHTM 03-01 (2009) in Table A1 that an Endoscopy Room should have 15 ACH and positive pressure.

[190] **A41683249** - QEUH – Ward 4B Works (report by Brookfield Multiplex) dated 22 July 2015. - Scottish Hospitals Inquiry - Hearing Commencing 24 April 2023 - Bundle 13 - Witness Statements - Page 1212
[191] **A49387011 -** Email from P Moir to G Jenkins regarding Haemato-Oncology - Level 4 Ward B works - 29 July 2015
[192] **A44943548** - 01 Physical changes Ward 4B.
[193] **A39465079** - adult BMT 2015, 2 - Scottish Hospitals Inquiry - Hearing Commencing 24 April 2023 - Bundle 13 - Witness Statements - Page 856
[194] **A41686378** - QEUH Ward 4b Ceiling Works.
[195] **A38029704** - QEUH – Adults Ward 4B rev1 – November 2017
[196] **A35185320** - Adult Isolation Rooms requirements
[197] **A49386768 -** Email chain between C Williams, J Brown, S McNamee, F McCluskey regarding Highly Infectious patents in the NSGH and other issues - 11 to 12 August 2014

8.53 In August 2018, work was to start to identify air changes within endoscopy rooms. Dr Inkster created an SBAR to detail the required air changes for procedure and what air change rates endoscopy suits within NHS GGC currently have[198].

8.54 On 19 May 2020, it was noted in an email from Dr Peters to Angela Wallace that the endoscopy suites may be deviating from standards and there should be a follow up action plan[199].

9. Introduction (RHC section)

9.1 The Royal Hospital for Children (RHC) is a 256 bedded children's hospital that was handed over to Greater Glasgow Health Board on 26 January 2015. Migration from the Yorkhill site took place between the 10 - 14 June 2015 and the RHC was fully occupied from the 15 June 2015.

10. Ward 2A – paediatric Bone Marrow Transplant (BMT) Unit

10.1 Ward 2A is the paediatric-oncology Unit and includes the Teenage Cancer Trust and the paediatric Bone Marrow Transplant (BMT) Unit - the department is known as the Schiehallion Unit.

Background

10.2 The Clinical Output Specification (COS) for the Haematology & Oncology area in the Children's Hospital covered the following areas:

- General In-patient Ward (high dependency)

[198] **A48818504** - Bundle 13 – Additional Minutes Bundle (AICC/BICC etc); - Scottish Hospitals Inquiry - Hearing Commencing 24 April 2023 - Bundle 13 - Witness Statements -
[199] **A46157878** - Email from C Peters to A Wallace and others re Current Issues – 19 May 2020

- National Bone Marrow Transplant Unit
- Teenage Cancer Trust Ward and Day-Care facilities
- Short-Stay / Day-Care Unit (incorporating the Regional Haemophilia Unit)
- Clinical Administration Facilities
- Outpatient Facilities[200]

10.3 The COS provided information on location and links, activity, trends, hours of service, workload indication, key operational policies/issues and patient pathways.

10.4 The COS provides little detail regarding technical requirements for the Haematology & Oncology department. It notes that “The National Bone Marrow Transplant Unit (BMT Unit), utilises special facilities incorporated into both the General In-patient Ward and the Day-Care Unit”.

10.5 Under Accommodation requirements for the General In-patient ward it states: “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”.

10.6 The COS did not refer to HEPA filtration requirements, exact pressure ratings or air change rates for the Bone Marrow Transplant Unit Isolation Rooms

10.7 The Room Data Sheet notes the air change rate for the ensuite as 10ACH but values for the lobby and patient bedroom are blank with a note under Mechanical Notes confirming:

[200] **A35761962** - New Children's Hospital - Clinical Output Specification - Haematology and Oncology - RHC - Scottish Hospitals Inquiry - Hearing Commencing 19 August 2024 - Bundle 20 - Documents referred to in the Expert Reports by Andrew Poplett and Allan Bennett - Page 1599

> "See HBN 04-01 Supplement 1 for further details of specific requirements".

Under Design Notes the following comment is included

> "WARNING NOTICE: This room is based on a theoretical design model; which has not been validated (see paragraph 1.8 of HBN 4 Supplement 1). Specialist advice should be sought on its design"[201]

What was handed over in the paediatric Bone Marrow Transplant (BMT) Unit

10.8 The paediatric Bone Marrow Transplant Unit was made up of 8 isolation rooms. All 8 of the isolation rooms in ward 2A were Positive Pressure Ventilated Lobby (PPVL) rooms.

10.9 The Isolation rooms were handed over with no HEPA filters fitted in the supply terminal grille in the lobby, however these were fitted in June 2015 prior to patients moving into the ward.

10.10 The PPVL rooms that were handed over in ward 2A varied from the design set out in SHPN 04-01 Supplement 01. In SHPN 04-01 Supplement 01 a PPVL room indicates an air supply into the lobby with an extract in the ensuite, however the PPVL rooms handed over in Ward 2A included an additional extract in the patient's bedroom. This variation to the SHPN 04 01 design appears to have been agreed during the RDD process with Brookfield [202].

10.11 It was also reported that there was no pressure monitoring system linked to the Nursing station to advise when pressures were not being provided or maintained (J.Leiper Report).

Issues with the Paediatric BMT Isolation Rooms - 2015

[201] **A45529919** - Ward 2A Room Data Sheets - Excerpt of A38110665
[202] **A34466372** - WID_001_1_00000002-016864 - Scottish Hospitals Inquiry - Hearing Commencing 19 August 2024 - Bundle 12 - QEUH Estates Team - Page 785

10.12 Issues with the Isolation rooms were first highlighted in June 2015, when it became apparent ‘none of the transplant rooms have hepa-filters fitted!”

10.13 HEPA filters were installed in the Isolation rooms on the Schiehallion Ward with the work complete and HEPA filter integrity test results completed on 6th and 7th June 2015[203].

10.14 High particle counts ranging from 519 to 163, 306[204], were reported in July. Particle counts should have been < 1000 at 0.5um[205]. Clinical staff were also reporting that they did not have guidance on when a room should be closed for use.

10.15 Light fittings in isolation rooms were not sealed resulting in an unsealed room. On the 2nd July 2015 Rooms 18 and 17 had the light fittings sealed. On the 6th July Teresa Inkster emailed Craig Williams requesting confirmation of when the remaining 6 rooms will have light fittings sealed and stresses that the work needed to be carried out asap as a second transplant was due to be undertaken.

10.16 On the 7th July Mary Anne Kane forwarded an email to Ian Powrie and Peter Moir stating:

> “It is imperative that we get the validation data now for all HEPA filtered areas of the hospital. We are at risk of losing all of the areas from use unless we provide this data which will be a PR nightmare for the Board”.

10.17 On the 10th July Craig Williams confirmed that all light fittings were replaced.

[203] **A34324094** - Childrens Isolation Room HEPA filter integrity test report - 7 June 2015
[204] **A49378414** - Email Chain between P Joannidis, J Kirkwood, S Leighton, A McVeigh, T Inkster, B Lavery regarding Schiehallion testing - 2 to 6 July 2015
[205] **A49378414** - Email Chain between P Joannidis, J Kirkwood, S Leighton, A McVeigh, T Inkster, B Lavery regarding Schiehallion testing - 2 to 6 July 2015

10.18 On Monday 10 August 2015 a meeting was held to discuss concerns regarding the BMT Unit. Agreed actions were recorded and an extract of those actions include:

a) Provide confirmation of the Specification document used for the design and build,(Scottish Building Notes 2008);
b) Provide confirmation the facility has been built in accordance with that specification;
c) Provide confirmation of commissioning of the facility; –
d) Call round of similar units elsewhere in the UK to identify their facilities configuration (lobbied rooms, positive pressure etc) based on an agreed questionnaire template;
e) Identification of further actions which could improve performance of existing facility;
f) testing of seals;
g) adjustment of pressure;
h) relocation of any external environmental factors;
i) further deep cleaning of rooms [206].

10.19 On 25 August 2015 Peter Moir provided a "draft response to Grant's [Archibald] questions based on our discussion yesterday" He confirmed in the email that the 8 isolation suites were designed and constructed to meet Scottish Health Planning Note 01 (SHPN 04) in patient Accommodation Supplement 1 and this was "confirmed as the correct document for this type of ward." He stated:

> "SHPN 04 also makes reference-under 1; 10. of an exclusion for specialist facilities where severely Immune-compromised patients are nursed. The document notes that guidance for these facilities will follow in a further supplement to SHPN 04 although no such guidance has been issued".

10.20 Under 3.0 of the draft response Peter Moir referred to:

[206] **A48652586 -** RHSC BMT Meeting - 10 August 2015

"Identification of what other actions ICT /Estates require to be conducted to make the rooms operational.

ICT/Estates recommend a two stage approach ..

- Stage one - to bring 2 rooms into operation (18 and 19)
- Stage two – to all rooms on a phased basis (when available)".[207]

10.21 On 26 August 2015 Craig Williams confirmed in an email to David Loudon: "As part of the work we are doing around the paediatric BMT we were asked to identify other units using positive pressure lobbied side rooms. There were a number of these across the UK but at the last meeting Leeds and Sheffield were identified as the most appropriate comparators".[208]

10.22 Ian Powrie follows up in an email on the 28th August 2015 and confirmed:

"Leeds Children's Hospital, BMTU is 4 years old, and is a retro fit· development within a 40 year old building. They have four isolation suites with the design based on HBN 04-01 supplement 1, all four suites are supplied from single AHU with stand by AHU resilience, complete with H13 HEPA filtration within the AHU, there are no terminal HEPA's installed in the suite. The facility is lobbied with an en-suite anti-room [sic], The supply air is provided via the lobby which sits at a 8-12pa differential pressure to the corridor, with a pressure balanced transfer grille. from the lobby to the isolated bedroom. The lobby door and room door are interlocked to activate a local alarm should the door be left open. The bed room is at a differential pressure of 20-25pa to the en-suite, where the extract is 152 ltrs/s split 60% from en-suite and 40% from the bed room, there are no transfer grilles between the bed room and the en-suite" ...

[207] **A49378413** - Emails between P Moir, C Williams, J Redfern, I Powrie, D louden regarding Schiehallion BMT Suite - 25 to 31 August 2015
[208] **A49378415** - Emails between I Powrie, C Williams, D Loudon regarding Paediatric BMT - 26 to 28 August 2015

10.23 Tests carried out on 1st September 2015 confirmed that high air particle counts were still being recorded in rooms 18 and 19 – particle counts ranged from 5363 in patient bedroom 19 to 1410 in Room 18, patient bedroom [209].

10.24 On 2nd September Capita issue a Supervisor's Notification of Defect to MPX stating:

> "Following the discovery that Air Permeability Tests were not carried out within 36 isolation rooms in accordance with the Employer's Requirements NHS Guidance Documentations, document HBN 04-01. We recognise that you are in the process of carrying out test to these rooms and any necessary work to ensure that they comply. Please provide the test results for all room and confirm when the works are complete"[210].

10.25 Gillon Armstrong, Section Manager from MPX, sent an email to Peter Moir on Friday 28th August 2015 that contained an attached report from RSK Environment Ltd regarding Isolation room test results:

> "Testing was undertaken to prove compliance with the requirement of HBN 04 Supplement 1 – Isolation Facilities in Acute Settings. This requires that the enclosure have 'an average leakage rate of no more than 1 l/s of air per m3 of envelope volume' at a positive and negative pressure differential of 20Pa. Further, the measured positive and negative leakage rates should be within 5% of each other".[211]

10.26 David Wilson (Commissioning manager MPX) confirmed issues with Isolation room Air Permeability Testing in an email to David Loudon and Ian Powrie on 20 May 2015:[212]

[209] **A34465872** - FEA_001_1_00000001-024423 - Bundle 12 - QEUH Estates Team - Page 363
[210] **A34323069** - Capita - Air Permeability Tests - 2 September 2015
[211] **A34465854** - Email between G Armstrong, P Moir, S Borland regarding Isolation room test - 28 August 2015
[212] **A34467041** - Email Between D Wilson, D Loudon regarding NSGH A&C issues - 20 August 2015

> "We have also previously highlighted (both verbally and when emailing test results) that although the test results from the permeability tests have achieved the leakage rate criteria some have not met the 5% difference between the positive and negative results. During a meeting with Craig Williams (with myself, Ian, Peter Moir, Mary Anne Kane present) we discussed this and my understanding was this had been accepted, however I believe this has now altered (after microbiological testing in Schiehallion)."

10.27 On the 1st September 2015, David Loudon sent an email to Alastair Fernie (MPX) stating:

> "The Board has taken a decision to request that the environmental standards noted at the Leeds Children's Hospital be considered for the Schiehallion Ward in the Royal Hospital for Children
> You will appreciate the urgency behind his request and therefore, I would appreciate if you will expedite answers to the following questions:
>
> Can the current air handling systems be adapted to achieve the environmental standards being achieved at Leeds? I have cut & pasted Ian Powrie's email dated 28th August. You will note that the design is to HBN 04-01 supplement 1 and associated tables. I understand that contrary to the Leeds set up, a transfer / balance grill may be required on the bedroom door to the lobby.
>
> I understand that BM has previously visited the rooms with an H&V consultant who has advised that the environmental standards should be deliverable in the Schiehallion Wards. Can you advise by return Assuming that the environmental standards can be achieved within the Schiehallion suite, can you provide an indication of timescale. Owning to the urgency, the Board would expect 24/7 levels of activity."[213]

[213] **A34465945** - Email from D Loudon to A Fernie, J Armstrong, G Archibald, C Williams regarding Schiehallion ward - 1 September 2015

10.28 An email chain follows from Brookfield with Alasdair Fernie (Project Director MPX) querying if they were to provide smoke sealed room[214].

10.29 A meeting chaired by Jennifer Armstrong was held on Monday 7th September 2015, to:

> "Identify the progress made in resolving the Bone Marrow Transplant (BMT) room estates issues in RHC and determine position for the paediatric haematology oncology service in being able to start new cases. JA [Jennifer Armstrong – Chair] acknowledged the clinical frustration about progress and the need to plan for patients currently waiting transplant".[215]

10.30 10th September 2015 – Teresa Inkster stated in an email dated 10 September 2015, to Sandra McNamee:

> "In light of the Information currently available to us, Alison, Pamela and I feel that we must err on the side of caution and cannot recommend that the unit is safe for transplant procedures".[216]

10.31 The Chief of Medicine, Women and Children, Alan Mathers provided 2 SBAR's to Jamie Redfern, copying Jennifer Armstrong, regarding BMT services at RCH. The first focuses on a "Pressing and Acute" case,

> "So the narrow question is whether we have any evidence that treating the child in the current environment poses more of a threat than not treating him taking all of the related risks into account (donor loss, deterioration, delay in another centre accommodating case-if option-infection, etc)"

[214] **A34465774** - Email chain between I McKenzie, J Miller, A Fernie, W Hunter, D Loudon regarding Schiellion Ward - 1 to 3 September 2015
[215] **A49378412** - MEETING TO DISCUSS BMT UNIT RHC - 7 September 2015
[216] **A48800307** - Email chain between Dr Teresa Inkster, Jamie Redfern and others regarding Sealing of Suites in Children's Ward 2A - 9 September to 23 October 2015

10.32 The second SBAR focused on upcoming cases noting:

> "We should progress Estates Work ASAP to build contingency and infrastructure options ASAP". [217]

Issues with the Paediatric BMT Isolation Rooms - 2016

10.33 At a meeting held on 21 January 2016 by the Chief Executive, it was agreed that the Deputy Project Director and Sector Estates Manager would comment on the action point, "establish if the proposed increase of extract in the en suite rooms in the Schiehallion Ward is a betterment over the original specification for the rooms".

10.34 David Loudon drafted a report on the Design, Construction and Commissioning Process for the Adult Hospital – Ward 4B (BMT) dated 25th February 2016 noting: [218]

> **"**Children's Hospital – Schiehallion Ward Extract Ventilation
> It is apparent that a difference of professional opinion prevails between Brookfield Multiplex designer, The Board's Technical Advisor and the Boards Sector Estates Manager regarding compliance with guidance note SHPN 04 – supplement 1."

10.35 David Loudon emailed Douglas Ross (Director Currie & Brown) on 1 March 2016, regarding the Isolations rooms in the Schiehallion Unit – see extract below:

> "I am writing to advise you that colleagues within the Boards Infection Control Team and Estates Department have raised concerns that in

[217] **A38694847** - Email dated 15 September 2018 - SBAR re viability of BMT in RHC - Bundle 4 - NHS Greater Glasgow and Clyde: Situation, Background, Assessment, Recommendation (SBAR) Documentation - Page 13
[218] **A41683176** - BMT REPORT - V3 - 25 February 2016

their opinion, the design of the extract ventilation within the isolation rooms is not compliant with SHPN04- supplement 1".

10.36 A report prepared by Ian Powrie, dated 21st January 2016, was included with the letter. The report referred to:

"Question
Establish if the proposed increase of extract in the en-suite rooms in the Schiehallion ward is betterment over the original specification for the rooms".[219]

10.37 The report highlights that:

"The isolation rooms are designed and constructed to meet the requirements of: Scottish Health Planning Note 04 {SHPN 04} In-patient Accommodation: Options for Choice Supplement 1: Isolation Facilities in Acute Settings.
' The purpose of this guidance is to provide guidance on the facilities required for isolating patients on **acute general wards** and explains "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;"

"However this guidance states under Exclusions, Para 1.10 (page 4): *"This Supplement does not describe the specialist facilities required in infectious disease units or on wards where severely immune-compromised patients are nursed. Guidance for: these facilities will follow in a further Supplement to SHPN 04."*

10.38 The report confirms that two extracts were located in the paediatric BMT isolation rooms. One in the patient bedroom and the other in the ensuite. The report states:

[219] **A33642636** - Letter from Currie & Brown to D Loudon regarding Isolation Rooms - 15 March 2016

"It should be noted that the recommended ventilation layout illustrates the supply air grill in the pressurised access lobby, full extract within the en-suite facility and transfer grilles on or above the doors from the isolated room to the positive pressure access lobby and to the en-suite, there is no extract from the isolation room itself which should always be held at positive pressure"

And continues:

"Where immuno-compromised patients are to be accommodated, such as in transplant units or specialist cancer units, there could be a need for positive pressure isolation rooms."
In addition empirical data collected between estates and the site ICD: currently indicates that when the en-suite door is left opened to the isolation room under the above ventilation arrangements, then the high extract rate in the isolation room results in the isolation room becoming negative compared to the en-suite room increasing the risk of contaminant ingress from the en-suite, particularly as the WC's are designed without the toilet seat lids to contain the resultant plume when flushing".[220]

10.39 The report concludes:

"Reviewing the evidence in this report it is quite clear regardless of the disclaimer in Para 1.10, that the current design arrangements do not meet the design intent OF SHPN 04 supplement 1 and therefore the proposed modification to bring these rooms in line with this guidance is not betterment *over the original ER's which state that Brookfield have requirement to design all facilities in line with the appropriate guidance"*[221].

10.40 In an email from Alastair Fernie (MPX) to David Loudon regarding the isolation rooms in Schiehallion:

[220] **A33642587** - Ref Doc DJR_13b enclosures with letter to Currie and Brown from D Loudon - 01 March 2016
[221] **A33642587** - Ref Doc DJR_13b enclosures with letter to Currie and Brown from D Loudon - 01 March 2016

> "We would note that SHPN04 Supplement 1 is a guidance document and, as is highlighted in Ian's report, excludes specialist facilities such as infectious disease units or on wards where severely immune-compromised patients are nursed (Paragraph 1.10) which now appears to be the criteria that the Isolation rooms particularly in in the Schiehallion ward are being scrutinized.
>
> In addition to this we have looked back at the drawing approval process for the Isolation room ventilation and noted that the first drawings that were issued to the NHS Project team as part of the RDD process did represent what is now being asked for ? en-suite extract only (Rev 1 drawing attached) but during the RDD process / meetings the solution was changed to what was then constructed and commissioned ? extract in the ensuite and isolation room (Rev 4 drawing attached). This solution was signed off Status A by the board and their advisors Capita. It's worth noting that at no point during the construction and commissioning / witnessing process was it highlighted that the signed off solution was incorrect or not what was required". [222]

10.41 Douglas Ross (Director Currie & Brown) responds in a letter to David Loudon on the 16th March 2016 (the letter date refers to 2015 but we presume this a typo) stating:

> "The baseline document (NEC3 Works Information) for determining compliance is SHPN01 - supplement 1 and responsibility for compliance rests with Brookfield Multiplex. Approval that works have been completed in accordance with the works information rests with the NEC 3 Supervisor.
>
> Brookfield Multiplex have stated, via TUV SUD Ltd, that they have complied with the requirement of Table 1 - Isolation Site Parameters included in SHPN01. The statement in the Board briefing note 'Action

[222] **A34466372** - WID_001_1_00000002-016864 - Bundle 12 - QEUH Estates Team - Page 785

> Plan for BMT and Theatre Operations at 21 January 2016' includes an opinion that the guidance in Table 1 refers to rooms being modified and not new build situations. There is nothing in SHPN01 that states this and as such Table 1 is the Boards requirements (works information).
>
> Should it be proven that the requirements of SHPN01 - Supplement Table 1 have not been complied with and the rooms are not performing to the necessary performance criteria, then Brookfield Multiplex should address remedial action.
>
> If additional performance criteria are now been requested, then the compensation event process would apply". [223]

10.42 A meeting with NHS GGC estates, Infection Control and clinicians was held on the 22nd September 2016 to review the suitability of Ward 2A BMT Isolation Rooms for Neutropenic BMT patients.

10.43 It was agreed at this meeting that 4 of the 8 transplant rooms should be upgraded to a higher specification and "the upgrade work would need to reach specification SHTM 03-01". It was also noted:

> "In the interim period the remaining 4 cubicles not being upgraded will be used for stand down capacity for BMT patients. Consideration will be given at a later date as to whether these cubicles require to be upgraded in phase 2 of the programme of works." [224]

Issues with the Paediatric BMT Isolation Rooms - 2017

10.44 In April 2017 Hulley & Kirkwood Consulting Engineers Ltd were appointed by NHS GGC Estates to review a selection of Isolation rooms in the RHC and QEUH – the review focused on the following areas:

[223] **A33642636** - Letter from Currie & Brown to D Loudon regarding Isolation Rooms - 15 March 2016
[224] **A41602358** - BMT Cubicles Minutes - 22 September 2016

- "Changing of 4No. PPVL isolation rooms (17,18,19 & 20) within Ward 2A to positive pressure isolation rooms for the continued use for transplant and severely immune-compromised patients.
- Review of PPVL isolation rooms (43 & 44) within Adults ICU for compliance against HBN 04-01 Supplement 1 (Base Build Specification). However SHPN 04 Supplement 1 will be utilised as this is specific guidance for Scottish Healthcare Facilities. Where any differences are evident these will be identified in ***bold italics***).
- Review 2No. Isolation rooms (5 & 12) within PICU and provide comment on compliance.
- Coordinate with Department of Health to assist with obtaining confirmation on what Hazard Classification of patient can be nursed within PPVL Isolation Rooms that comply with SHPN/HBN 04-01 Supplement 1."[225]

10.45 The report provided an overview of the existing system – see extract below:

"The existing isolation rooms fall into two categories:

- Single bed rooms with PPVL and en-suite.
- Single bed rooms with PPVL and no en-suite.

The latter type is common in hospital departments where the patient group would be unable to utilise en-suite facilities due to their state of health e.g. intensive care".

"All of the facilities are provided with dedicated supply air handling units partnered with dedicated extract systems. The ventilation plant configuration and duty capability is generally in compliance with HBN 04: Supplement 1 however there is no evidence that the supply systems were commissioned taking into consideration the future pressure drop when a Hepa filter would be inserted.

[225] **A41602399** - Hulley & Kirkwood Isolation Room Review - QEUH and RHC Isolation Rooms Review Rev1

"The following typical items are noted as requirements that are either not evident within the installations or are contrary to the guidance in the document. These are discussed further within sections 3.0, 4.0 & 5.0 including scope / cost required to meet requirements identified within section 1.0

a) Rooms of type (a) have been provided with the majority of the extract ventilation taken from the bedroom at ceiling level with a lesser volume extracted from the en-suite at ceiling level. This is contrary to clause 4.12 which requires all extract to be taken from the en-suite unless clinical requirements determine that some extract is to be taken from low level at the bedhead.
b) Rooms of type (a) have no low level air transfer grilles installed within the door to the en-suite. This is contrary to clause 4.13.
c) Excessive access hatches have been installed on the supply and extract ductwork. This is contrary to clause 4.15.
d) There appears to be no provision for a gas tight shut off damper or spectacle plate on the extract systems prior to the extract fans. This is contrary to clause 4.14. (Note that al survey of above ceiling runs was not achievable due to operational issues.)
e) There are no audio and visual alarms located outside the room lobbies to warn staff of unsafe conditions. This is contrary to clause 4.22.
f) There is no provision for a common alarm panel located at the nurse station. This is contrary to clauses 4.6 and 4.22.
g) The supply and extract duct access hatches have not been identified as a bio-hazard. This is contrary to clauses 4.15 and 4.19.
h) The supply and extract plant and duct systems have not been identified with the rooms that they serve. This is contrary to clauses 4.15 and 4.19.
i) Where safe change filter housings have been provided as opposed to vertical discharges they have not been installed external to the building. This is contrary to clause 4.16. Fire compartmentation strategy will require reviewed taking the above into consideration.

j) The existing dial pressure gauges monitoring lobby positive pressure are inappropriate for monitoring a 10Pa pressure differential. 30-0-30 Pa is preferred as what has been installed within PICU.
k) No envelope permeability test carried out".[226]

10.46 The report states:

> "There would not appear to be any published UK NHS guidance on the design of Positive Pressure (PP) Isolation rooms. However it is reasonable to take guidance from SHTM 03-01 and in particular the guidance pertaining to operating theatre ventilation system design". [227]

10.47 The report provides detail on how the PPVL isolation rooms should be modified to Positive Pressure Isolation rooms. A cost plan summary was provided with a positive pressure isolation schematic drawing.[228]

10.48 Hulley & Kirkwood issued a draft tender report in May 2017, for modifying Ward 2A Isolation Rooms[229]. The report provided details for changing 4no. PPVL isolation rooms (17,18,19 & 20) to positive pressure isolation rooms noting "that the works will be carried out in a live ward environment and management of cleanliness is a critical factor to ensure no cross contamination within the live ward environment."

10.49 The project was to be priced on two potential scenarios:

- All 4no rooms are available to work in (17,18,19 & 20)
- 2no rooms are available (17 & 18) and on successful validation and acceptance by clinical team rooms (19 & 20) will be made available.

[226] **A41602399** - Hulley & Kirkwood Isolation Room Review - QEUH and RHC Isolation Rooms Review Rev1
[227] **A41602399** - Hulley & Kirkwood Isolation Room Review - QEUH and RHC Isolation Rooms Review Rev1
[228] **A41602399** - Hulley & Kirkwood Isolation Room Review - QEUH and RHC Isolation Rooms Review Rev1
[229] **A41602356** - Hulley & Kirkwood Isolation Room Review - QEUH and RHC Isolation Rooms Review Rev1 – Appendix A

10.50 Details on modifying the rooms from PPVL to Positive Pressure Isolation Rooms were provided as was a Descriptions of the Works and a Summary Bill.

10.51 On 30th May 2017, an Invitation to Tender specification was issued on Public Contract Scotland. The report repeats much of what was outlined in Hulley & Kirkwood's draft tender report but provides additional detail relating to Contract Award Criteria, with weighting breakdown and scoring methodology[230].

10.52 Morris & Spottiswood were appointed to carry out the works with a purchase order raised in August 2017 to carry out ventilation modifications as per tender award report (The Inquiry Team do not hold a copy of this report).

10.53 In October 2017, QEUH ICDs produced an SBAR titled 'SBAR: 2A Patient Accommodation and Risk of Invasive Fungal Disease', which stated:

> "Ward 2A at the RHC houses the Haematology-oncology Paediatric services including the Scottish Paediatric Bone Marrow Transplant Unit. Since the unit opened in 2015 ICDs have expressed concern regarding the ventilation and building spec of the unit with regard to effective airborne protection of high risk patients on a number of occasions."

10.54 Under Assessment it states:

- High risk patients are treated regularly on the ward, currently ALL patients on induction chemo are not housed in HEPA filtered rooms and there are not enough HEPA-filtered rooms for the numbers of BMT patients on the ward on occasion and are being housed in the non-HEPA filtered rooms.
- The current configuration of ventilation has extensively been discussed by Dr Inkster and Estates and the Board have agreed to upgrade the PPVL rooms into positive pressure rooms that will meet the specifications for high risk patient protection.

[230] **A41602401** - Tender Issue - Ward 2A Isolation Room Ventilation Specifications - 30 May 2017 FINAL

- The work for this upgrade is pending in November - there is an increased risk of IFA during this work and measures to protect the vulnerable population have been discussed between Prof Jones and Prof Gibson including the use of prophylaxis.
- There are currently extensive demolition projects ongoing at the QEUH site which increases the risks of IFA in the immune compromised population.
- Currently all patients who are neutropenic or on high dose steroids are being given antifungal prophylaxis – either ambisome or posaconazole, including the solid organ cancer patients at risk of fungal infection.
- Currently there are 3 HEPA filtered rooms that are out of use to our knowledge: room numbers: 19, 24, 25? However it would be useful to confirm this.
- Air sampling baselines are not well established on the unit – as the spec is entirely different from the Beatson, 4B and old York hill ward, there is no established agreement on the cut off values for particle counts or CFU for the non HEPA filtered rooms. This is causing confusion and misunderstandings with regard to appropriate course of action on receiving these results".

Recommendations included:

- "Air sampling regime and interpretation is clarified by ICSMT and cumulative
  results presented for each room, with clarity on the reports whether the rooms are HEPA filtered or not.
- A reduction in turn around time for ID of organisms is achieved by laboratory Intensified air sampling should occur during periods of construction work both within the unit and on the QEUH site.
- Clear guidance is produced regarding the risk assessment around the housing of ALL, and other high risk patients in the non-HEPA filtered rooms when these rooms are not available.

- Further consideration is given to risk mitigation measures to be put in place pending the completion of the upgrade works including use of masks on
  moving around site and advice regarding routes into and out of hospital.
- Consideration may also be given to use of mobile HEPA filtration units".[231]

10.55 Following the October 2017 SBAR a report titled 'Report on Concerns Raised re Queen Elizabeth University Hospital (QEUH) and Royal Hospital for Children (RHC)' dated 05.12.2017 addressed concerns raised by three consultant microbiologists about the facilities in QEUH and RHC. Issues raised by the IPCT were set out in an action plan, with the 'Current Position' and 'Future Actions' confirmed. Some of the issues related to isolation rooms, in particular PPVL rooms were not compliant with SHTM standards and PPVL rooms did not provide appropriate protection for patients with infectious diseases of high consequence (IDHC) e.g. MERS, SARS[232].

Issues with the Paediatric BMT Isolation Rooms – 2018

10.56 In January – March 2018, isolation rooms Bed 18, Bed 19, Bed 20 and Bed 17 were converted from PPVL isolation rooms to Positive Pressure Isolation rooms[233].

10.57 In January 2018 HPS provided an SBAR in response to concerns raised regarding the suitability of the 8 isolation rooms to house predominantly severely immunocompromised and/or bone marrow transplant recipient children. The SBAR states:

[231] **A38694862** - SBAR: 2A Patient Accommodation and Risk of Invasive Fungal Disease - Bundle 4 - NHS Greater Glasgow and Clyde: Situation, Background, Assessment, Recommendation (SBAR) Documentation - Page 113
[232] **A38759270** - Action Plan arising in response to SBAR dated 3 October 2017 - Bundle 20 - Documents referred to in the Expert Reports by Andrew Poplett and Allan Bennett - Page 792
[233] **A44943477** - S.21 response from GGC July 2023, '05 a) and c) Isolation Rooms RHC'

> "NHSGGC are undertaking work to convert four of the eight PPVL rooms to isolation rooms utilising the existing plant. This will result in the room becoming positively pressured, with the extract grille in the ensuite. The pressure cascade will be compliant with that of a theatre (in the absence of specific BMT guidance). The room will achieve 10 air changes and the pressure gauge will measure the pressure between the room and the corridor."

10.58 The chronology response provided by NHS GGC in response to RFI 10, section 1 notes that the SBAR "was received after works were commenced so NOT part of the decision making process to undertake the works." [234]

10.59 The SBAR notes that the assessment and recommendations are generally in line with those made in relation to the adult BMT Unit with "Validation of the entire system should be as detailed in SHTM 03-01 part A and verification of the entire system should be as outlined in SHTM 03-01 part B. The frequency of verification should be at least annually or more frequently if issues arise", some recommendations include:

a) "The rooms must be positively pressured at 10 Pa.
b) ALL air entering the room must be via the HEPA filter.
c) The HEPA filter should as a minimum be E12 (H13) and located within the supply air diffuser.
d) The rooms must be sealed and no air which has not passed via the HEPA filter should access the room.
e) There must be a continuous pressure monitoring system for each room which alarms and gives an early indication of a pressure drop within the room.
f) Bedroom Air changes of 10 ACPH must be achieved.
g) The walls and ceilings within the rooms and ensuite must be sealed.
h) All room services must be sealed.

[234] **A41601693** - RFI 10 Chronology RFI 10 Final Draft response 1.1 -1.7 - 25 November 2022

i) Rooms must have achieved satisfactory validation and commissioning parameters".[235]

10.60 On the 20 February 2018, Morris & Spottiswood provided an Isolation Room Ventilation Works Construction Programme that shows work starting on rooms 17 & 18 on 19th February 2018 with the completion noted as 16th March 2018[236].

10.61 Following the works, H&V Commissioning Services Ltd provided Ventilation Commissioning and Validation Reports[237] [238]. The tests were carried out on 14th March 2018

Issues with the Paediatric BMT Isolation Rooms – 2018

10.62 In January 2018, HPS produced an SBAR regarding the isolation rooms in the Schiehallion ward. The SBAR confirms:

> "There has been concern raised regarding the suitability of these rooms in terms of protection for this category of patient. In addition there has been a number of patients reported to have fungal infections which may be healthcare related. Currently there is no UK guidance on BMT isolation rooms, and as a result NHSGGC have requested support."

10.63 Some of the recommendations include:

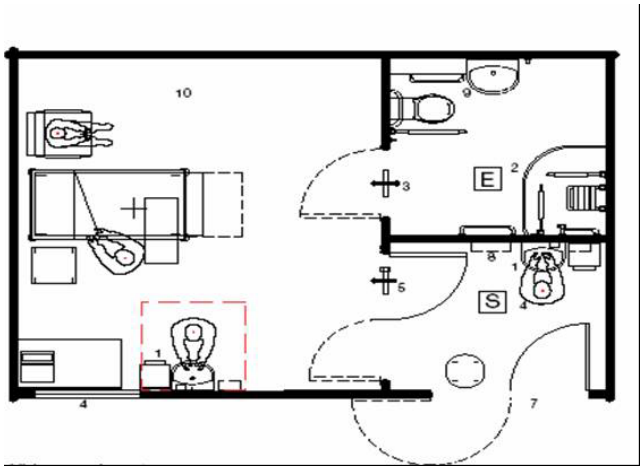
> "The recommendations relating to ventilation to allow the provision of a protective environment for patients isolated within the isolation rooms of Schiehallion ward are;
>
> a) The rooms must be positively pressured at 10 Pa.
> b) ALL air entering the room must be via the HEPA filter.

[235] **A32310961** - SBAR dated January 2018 - Environmental/Ventilation -Schiehallion Unit RHC' - Bundle 3 - NHS National Services Scotland: SBAR Documentation - Page 62
[236] **A41602373** - Construction Works Programme Isolation Room Ventilation Works - RHC Ward 2 Glasgow CONSTRUCTION ISSUE
[237] **A41602393** - H&V Commissioning & Validation Childrens 2A - Room 17 Isolation Rev1 - 14 March 2018
[238] **A41602393** - H&V Commissioning & Validation Childrens 2A - Room 17 Isolation Rev1 - 14 March 2018

c) The HEPA filter should as a minimum be E12 (H13) and located within the supply air diffuser.
d) The rooms must be sealed and no air which has not passed via the HEPA filter should access the room.
e) A strict protocol which minimises the length of time the door is opened and reduces air entry via an open door is required.
f) There must be a continuous pressure monitoring system for each room which alarms and gives an early indication of a pressure drop within the room.
g) Bedroom Air changes of 10 ACPH must be achieved.
h) The walls and ceilings within the rooms and ensuite must be sealed.
i) All room services must be sealed.
j) All service access hatches within the bedrooms/ensuite must be sealed.
k) Rooms must have achieved satisfactory validation and commissioning parameters". [239]

10.64 In July 2018, the NHS GGC Interim Director of Facilities, commissioned Jim Leiper to provide a report on the ventilation system in the QEUH. The report notes:

"The 'normally expected' ventilation system design and standard layout recommended for both 'Protection and Source Isolation' is given in the SHPN 04 Supplement 1. (See adjacent drawing).



[239] **A41602350** - SBAR - Environmental/Ventilation Monitoring - Ward 2B - January 2018

This is achieved by the placing of the full air extract from the space, within the ensuite area of the facility. There would normally be a pressure balanced air transfer grille in the door (as shown) between lobby and the bed area and between that and the ensuite to allow a passage of air when the doors are closed.
SHPN 04 Sup. 1 suggests how rooms that were not originally designed for 'Isolation' might be altered to achieve the most effective air flow configuration to afford the best possible solution from the prevailing room layouts.

***Comment**: Despite the suggested alteration solutions noted in the Guidance, one might reasonably expect the normal standard isolation configuration to be provided in a new build, when there are no constraints to the design of choice"*

10.65 The report provides some detail on the installed ventilation system, confirming:

"The Installed Ventilation System

The system actually installed by Brookfield, incorporated an extract grille on the ceiling in the patient's room and a further extract within the ensuite".

***"Comment**: The vast majority of the extract air flow in the installed arrangement, would be fully taken from the patient's room at the ceiling, with a small proportion of the extract ventilation taken from the ensuite. The ensuite extract is similar to that normally installed in general toilet facilities, primarily for the removal of odours.*
In circumstances where 'Source Isolation' of 'infectious patients' is necessary, (a different purpose than for the 'Protective Isolation' of patients), an arrangement that might be utilised is to have the supply of air flowing from the lobby to be extracted in full, from the patient's room

via an extract grille in the patient's room located at the patient's head, on the wall behind the patient. (SHPN 04 Supp. 1 Page 17 Section 4.12). The intention of this arrangement would be to allow an air flow from the 'positively pressured' lobby into the room; across the patient to the extract grille. This would also afford the staff caring for the patient some degree of infection protection from the patient in addition to creating the 'source isolation' of the patient. The placing of the extract in this arrangement would ideally be done in consultation with clinical colleagues with consideration of the type of airflow that would most benefit the patient being cared for.

Placing the extract grille on the ceiling of the patient's bedroom might lead to an airflow which does not effectively flow over the patient. The protection of staff caring for the patient may therefore compromised".

10.66 The report considers SHPN 04 Supplement 1 and states:

"SHPN 04 Supplement 1, states on Page 17, Section 4.2 - 4.4 (inclusive),

The isolation suite and its ventilation system are based on a validated design. The engineering guidance given in this Section aims to provide a practical, 'fail-safe' design solution for isolating patients on acute general wards".

***"Comment**: This guidance is intended for patient isolation on an Acute General Ward setting, not where highly infectious or neutropenic patients are being treated".*

"The ventilation system is designed on the basis that all its constituent parts, as described in Table 1, 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 ensuite bathroom. This ensures good airflow through the entire isolation suite. Similarly, the volumetric airflow rate in the lobby is determined by the number of air changes required in the patient's

bedroom. Modifying or failing to provide one element of the system will jeopardise the performance of the system as a whole".

***"Comment**: It could be argued, that from technical perspective, placing the extract within the isolation room is a modification to the normally expected design of this kind of isolation facility, particularly for the nursing of neutropenic patients (c.f. 4.4. below), but it would be difficult to argue this on a 'legal' basis as the guidance itself allows a degree of design latitude and there is an absence of standard guidance for specialist isolation facilities".*

……. "Where immunocompromised patients are to be accommodated, such as in transplant units or specialist cancer units, there could be a need for positive pressure isolation rooms."

***"Comment**: This has not apparently been taken into account in arriving at a solution provided*".[240]

10.67 An IMT held on the 28 September 2018, confirmed that following issues with the drains in Ward 2A:

"The full decant of patients from Ward 2A and Ward 2B was undertaken on Wednesday 26th September into Ward 6A and Ward 4BBMT in the QEUH".

10.68 A further IMT held on the 11th October 2018, confirmed that

"A report on the ventilation of Ward 2A/2B ventilation is due soon and if any problems detected they will look at the feasibility of rectification during the period the ward is decanted."

[240] **A41602105** - Jim Leiper Report - 2A Ventilation Findings. - JL Comment Ver Final - 01 January 2018

10.69 In October 2018 Innovated Design Solutions provided a feasibility study, titled ‘Increasing Air Change rates within Ward 2A’. This report did not consider the BMT isolation rooms but confirmed:

> “Following analysis of the current ventilation strategy within upper areas of Ward 2A (Mid-Ward & TCT areas), we anticipate the original accommodation design philosophy was not intended for use by patients with immune response impairment/deficiency. On the contrary, the existing ventilation strategy would appear only likely to promote the risks associated with uncontrolled ingress of infectious aerosols into patient areas”.[241]

10.70 The feasibility study confirmed “numerous significant deficiencies/inadequacies appertaining to the existing system” and “recommended consideration be given to the installation of completely new ventilation systems”[242].

10.71 Following this report a new ventilation system was installed in Ward 2A. All 8 AHU’s that served the isolation rooms were replaced and one of the remaining PPVL rooms (BED 23) was converted to a Negative Pressure Ventilated Lobby (NPVL) room[243].

10.72 Patients returned to Ward 2A in March 2022. [244]

[241] **A42362217** - Innovated Design Solutions Report - Feasibility Study Regarding Increasing Ventilation Air Change Rates within Ward 2A - QEUH/RHC - Commissioned by NHS Greater Glasgow and Clyde - 24 October 2018' - Scottish Hospitals Inquiry - Bundle of Documents for the Oral Hearing Commencing 12 June 2023 - Bundle 6 - Miscellaneous documents -
[242] **A42362217** - Innovated Design Solutions Report - Feasibility Study Regarding Increasing Ventilation Air Change Rates within Ward 2A - QEUH/RHC - Commissioned by NHS Greater Glasgow and Clyde - 24 October 2018' - Scottish Hospitals Inquiry - Bundle of Documents for the Oral Hearing Commencing 12 June 2023 - Bundle 6 - Miscellaneous documents -
[243] **A44943477** - S.21 response from GGC July 2023, '05 a) and c) Isolation Rooms RHC'
[244] **A41602083** - Ward 2A and 2B Project Board Report - 07 March 2022

Isolation Rooms – RHC – Ward 2A												
Location	**Ward Type**	**Bed Reference**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**
Ward 2A	Paediatric Bone Marrow Transplant Unit	17	PPVL (*June)	PPVL	PPVL	PPIR	PPIR	PPIR	PPIR	PPIR	PPIR	PPIR
		18	PPVL (*June)	PPVL	PPVL	PPIR	PPIR	PPIR	PPIR	PPIR	PPIR	PPIR
		19	PPVL (*June)	PPVL	PPVL	PPIR	PPIR	PPIR	PPIR	PPIR	PPIR	PPIR
		20	PPVL (*June)	PPVL	PPVL	PPIR	PPIR	PPIR	PPIR	PPIR	PPIR	PPIR
		22	PPVL (*June)	PPVL	PPVL	PPVL	PPVL	PPVL	PPVL	PPVL	PPVL	PPVL
		23	PPVL (*June)	PPVL	PPVL	PPVL	NPVL (May)	NPVL	NPVL	NPVL	NPVL	NPVL
		24	PPVL (*June)	PPVL	PPVL	PPVL	PPVL	PPVL	PPVL	PPVL	PPVL	PPVL
		25	PPVL (*June)	PPVL	PPVL	PPVL	PPVL	PPVL	PPVL	PPVL	PPVL	PPVL

Key	
PPVL	Positive Pressure Ventilated Lobby
NPVL	Negative Pressure Ventilated Lobby
PPIR	Positive Pressure Isolation Room
NPIR	Negative Pressure Isolation Room
*	HEPA Filtration added

11. Paediatric Intensive Care Unit (PICU)

11.1 According to tender 1:200 drawings submitted in 2009 (by MPX to NHS GGC), originally six lobbied isolation rooms were planned for the Paediatric Intensive Care Unit (PICU).[245] This is consistent with issue 4 of the Schedule of Accommodation (SoA), forming part of the Employers Requirements (ER).[246]

11.2 In the 1:200 drawings approved in 2010 by NHS GGC following a period of design development, two lobbies had been removed – creating the four lobbied isolation rooms and two single bed rooms, as built.[247] It is not clear to the Inquiry why the decision was made to reduce the number of lobbied isolation rooms during design development.

11.3 Concern had been raised prior to handover of the hospital in 2014 by the Lead Infection Control Doctor (ICD) at that time regarding the appropriate uses of PPVL isolation rooms. This was due a specific exclusion in the guidance for PPVL rooms, which stated:

> "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 SHPN 04".[248]

11.4 Having sought and received assurance from Wallace Whittle the PPVL rooms were accepted by the Lead ICD as being appropriate for the care of these patients. The assurance received was:

[245] **A35773467** - Tender 1:200, First floor plan NCH Critical Care (PICU) / Cardiology Ward/ Support - 2 September 2009
[246] **A35184890** - NSGACL Schedule of Accommodation NCH_iss1_rev - April 2009
[247] **A33017230** - Developed Design 1:200, First floor plan NCH Critical Care (PICU) / Cardiology Ward/ Support/ MDU and Special Feeds, Approved Level B - 15 October 2010
[248] **A40165237** - SHPN 04 Supp 1 v1 2008

> "…the isolation rooms throughout the hospital have been designed in line with SHPN 04 supplement 1. Wallace Whittle sees no reason as to why the isolation rooms cannot be used under the guidance issued previously by NHS". [249]

What was handed over

11.5 When the RHC opened to patients in June 2015, the Paediatric Intensive Care Unit was comprised of four four-bedded rooms, four isolation rooms and two single bed rooms.[250]

11.6 All four of the isolation rooms in PICU were Positive Pressure Ventilated Lobby (PPVL) isolation rooms. In PICU, these rooms were comprised of a lobby and a bedroom (with no ensuite).

Issues with PICU

11.7 In May 2016, when the hospital had been operational for a year, concerns regarding the appropriateness of PPVL isolation rooms for protective isolation of neutropenic patients and source isolation of patients with an airborne infection resurfaced among the Infection Prevention and Control Team (IPCT) and clinical staff. Concerns were also being raised with regards to the "basic engineering and lack of alarm systems" in PPVL isolation rooms throughout the hospital.[251]

11.8 As a result, a review of the PPVL isolation rooms by HFS was requested by physicians and the Lead Infection Control Doctor.

11.9 On 31 May 2016, a meeting was held between NHS GGC estates, its advisers and a representative from Multiplex to discuss the questions which would be asked of HFS. The purpose of the meeting was for the team "to be unified in

[249] **A38694871** - SBAR dated 26 April 2016 - Timeline ID SGUH - Scottish Hospitals Inquiry - Bundle of Documents for the Oral Hearing Commencing 12 June 2023 - Bundle 4 - NHS Greater Glasgow and Clyde: Situation, Background, Assessment, Recommendation (SBAR) Documentation - Page 20 - 26
[250] **A38694853** - SBAR dated 21 July 2019 - PICU RHC - ventilation issues (21 July 2019) - Bundle 4 - NHS Greater Glasgow and Clyde: Situation, Background, Assessment, Recommendation (SBAR) Documentation - Page 161
[251] **A32310958** - Infection Control letter to T Inkster - 5 May 2016

support of the submission of Question 2 and the supporting information for the main variations from SHPN 04 supplement 1". The two questions for HFS were:

> Question 1: "Is the ventilation design criteria set out in SHPN 04 supplement 1: Isolation Facilities in Acute Settings As detailed in Table 1: Isolation Suite – Ventilation Parameters and Sheet 2: New build single room with en-suite facilities and bed-access lobby (isolation suite), suitable for safe nursing of patients with the one of the following conditions?
>
> 1. Multi Drug Resistant TB (MDRTB)?
>   - MERS?
>   - H1N1?
>
> Question 2: "If the above design criterion is suitable for safe nursing of patients with any one of these conditions please advise if the following design variant is equally suitable?
> See attached schematic ref: ZBP-XX-XX-SC-524-871, along with a set of commissioning documents for a representative Critical Care Ward (CCW), isolation room ventilation arrangement within the QEUH. The following variations should be noted:
>
> 1. The main extract is located in the isolation room.
> 2. The alarm system to the nurse's base was deleted, including:
> - Room Lobby pressure gauge alarm.
> - The extract air flow switch; alarm to the nurses' base.
> - The supply air flow switch; alarm to the nurses' base.
>
> 3. The transfer grille between the isolation room and the en-suite was deleted". [252]

11.10 The above variations from the validated design in SHPN 04-01 Supplement 1 which NHS GGC noted were generated using an adult Critical Care isolation room as an example. The Inquiry notes that, unlike PICU isolation rooms,

[252] **A33642489** - QEUH Isolation Rooms Meeting (31 May 2016) - Bundle 20 - Documents referred to in the Expert Reports by Andrew Poplett and Allan Bennett - Page 1527; **A34121423** - Meeting invite with D Ramsay, S McKechnie, I Powrie, D Ross, D, Wilson, D Loudon regarding clinician isolation room concerns - 31 May 2016

the Adult Critical Care isolation rooms had ensuite facilities. Other variations noted by NHS GGC Estates were:

"SUPERVISOR (JMcE) INITIAL OBSERVATIONS (where access was gained) USING SHPN 04: SUPPLEMENT 1 AS REFERENCE

- Room pressure was sitting at 8pa. This was at the magnehelic and no true readings were taken to verify. Range should be between 10 and 12 pa. (Appendix 2 Acceptance Testing)
  DW confirmed that tests undertaken proved that a positive pressure of 10 Pascals between entry lobby and door had been achieved. JMcE requested confirmation of pressure readings taken between Isolation Room and Lobby and taken between Isolation Room and En-Suite. DW confirmed he would provide. DW to issue test results to Supervisor for review."

- No Alarms installed to indicate to clinical team of potential ventilation issues or remote alarm at nurses stations. Also demonstrated by low pressures having no indication (4.22)
  SHPN 04 Supplement 1 Section 4.22 states: - 'Audio and visual alarms must be located at the entrance to the lobby and bedroom to warn nursing and maintenance staff of potential unsafe conditions. Continuous monitoring should be provided with remote indication at nurses stations, interlinked to the Building Management System with time delay (adjustable by Estates personnel) to take account of running-up of standby motors or damper operations or other plant items that may take time to open or close.'

  DR explained that no alarms are provided to nurses' station as these were omitted by the Board in PMI 169 Nurse Call Interface which confirmed requirements of Nurse Base Panel and stated 'monitoring bedroom pressure, not required'. This was issued following a visit by Lead Nurse on the project and other project team members visiting example hospital in London. DW confirmed that pressure monitoring is linked to the BMS and alarms display on the main BMS control panel in accordance with the BMS specification.

PMI 169 states: - 'Description The Board confirm their nurse call interface requirements for the Adult & Childrens Hospitals as per the attached document. Instruction Incorporate the attached interface requirement into your design development process for the nurse call system.'
Attached interface requirement states:-

'NURSE CALL INTERFACE REQUIREMENTS
Following static workshop and visit to Royal London Hospital we have agreed that we need the following items integrated with Static system: - Nurse call, Door access, Fire alarm, Medical gas alarm, PTS notification, Bedroom temperature notification, Control of 3rd party TV from patient handset i.e. static handset capable of operating as TV remote with infrared on static bedhead.

We have discarded the following systems which they have used in RLH Bedroom pressure

We have also discarded the following applications offered by Static systems as part of their presentations
Patient information details, Patient 'wandering' system, Voice communication for patient to staff calls'

It was discussed that the PMI concerns the Nurse Call interface requirements and does not appear to specifically instruct the deletion of the Audio and visual alarms.
Brookfield to track the Design Development process consequent to PMI 169 to inform on the deletion of alarms.
With DRo agreement DW to obtain a quotation for providing audio and visual alarms and forward to DRo.

- The pressure stabiliser was not operating correctly. With corridor door open top blade remained open. Bottom blade appears to have no status change when doors are either open or closed.(4.21)
Brookfield to investigate and also forward pressure stabiliser testing and commissioning information to Supervisor.

- Door from lobby opens into room and in instance not closing properly leaving a greater leakage path and closing direction not as per exemplar within SHPN 04: Supplement 1. Sheet 2
  Brookfield to investigate and advise Supervisor. The inconsistency of lobby/room door handle provision was discussed with handles on some doors and push plates on other doors.

- Extract grille located within room ceiling and toilet. All air should be extracted via the toilet with low level transfer grille within door (4.12)
  SHPN 04 Supplement 1 Section 4.12 states: - An extract terminal should be fitted at high level in the en-suite room. An additional terminal may be fitted in certain circumstances at low level adjacent to the bedhead in the bedroom. The clinical requirement for this should be verified and such requirements would probably relate to highly infectious patients. Refer Actions in 1.1 and 4.2.

- Bed location not as per exemplar within SHPN 04: Supplement 1. Sheet 2
  JMcE identified that the location of the bed was not in the position shown in SHPN 04: Supplement 1. Sheet 2. DRo advised that this would have been a clinical decision.

- Supply AHU (We used AHU 16 as example) is not identified with what room it serves and neither is the ductwork. (4.19 & SHTM03-01)
  DW advised that this matter is tracked as a Defect in FM First Summary Schedule and will be corrected.

- Air Permeability (Leakage): We were advised this was carried out using the room volumes and not the envelope volumes. This will be checked on receipt of information noted within 2.2 above.
  Brookfield to issue Air Permeability results to JMcE for Supervisor review.

11.11 HFS provided its report on the isolation rooms in June 2016, noting that they were unable to advise if the rooms met the “expected or safe standards”, because information on air change rates had not been available.[253]

11.12 The report noted that the positive pressures recorded in the lobby did meet the parameters laid out in HBN 04-01 Supplement 1. In addition, leak tests met the leakage parameters set out in HBN 04-01 Supplement 1, suggesting the rooms were appropriately sealed.

11.13 With regards to any non-compliance with SHPN 04-01 Supplement 1, the report by HFS stated:

> “2. From the information provided there are a combination of single isolation rooms without lobbies and isolation suites with lobbies. Additionally there appears to be rooms noted as isolation rooms which do not have en-suite facilities.
> […]
> - 5. Considering the drawings provided for the isolation room lobby (NA-SZ-XX-AS-400-126 and NA-SZ-XX-AS-400-126_Z1) against the requirements of HBN 04-01 Supplement 1, it is noted that whilst the majority of items are provided, the following are not:
> - Storage for ‘other’ clean PPE (plastic apron, glove and mask storage provided)
> - Storage for room cleaning equipment
> - Facilities for completing and storing log books
>
> 7. Considering the drawings for the isolation rooms which were provided (NA-SZ-XX-AS-400-127-01 and NA-SZ-XX-AS-400-127-01_Z1), they show rooms with no en-suite as part of the design. This arrangement is also shown on schematic ZBP-XX-XX-SC-524-707 B. This arrangement is not part of HBN 04-01 Supplement 1, which notes

[253] **A32310951** - QEUH Isolation Rooms Report 2016 – Ian Storrar, HFS - Bundle 13 - Witness Statements - Page 601

> that an en-suite is a key consideration and provides a simple cost effective way to provide isolation […]
>
> 8. In general, the air handling units serving the isolation rooms supply and extract air from other rooms (non-isolation rooms). A common supply is permissible under the guidance in HBN 04-01 Supplement 1; there is no information provided on the control strategy to ensure that the supply system will deliver constant volume depending on the demand.
>
> 9. The ventilation extract from the isolation room en-suites and the isolation rooms themselves are extracted via a separate system which would appear to terminate at a louver on the side of the building. HBN 04-01 Supplement 1 notes that this extract should terminate at roof level at least 3m above the building height. It is not clear from the information provided if all the extract fans are supplied from the "essential" side of the electrical distribution or if they have any safe change housings for changing filters".

11.14 The report concluded that the isolation rooms at QEUH do not comply with the validated design provided by SHPN 04-01 Supplement 1 in the following ways:

- Some isolation suite extract ventilation would appear to terminate behind louvers on the facade
- Some extract ventilation would appear to terminate in formed turrets above plant rooms.
- Isolation suites may have been provided without en-suite facilities.
- Log books not available in lobbies

11.15 Regarding the PPVL isolation rooms without ensuite facilities, such as those in PICU, HFS advised they should not be used for the care of highly infectious/infectious patients because "Using rooms without en-suite facilities risks

possible cross transmission of infection as alternative methods for toilet facilities and personal hygiene must be made".[254]

11.16 In March 2017 Hulley & Kirkwood Consulting Engineers (H&K) were commissioned by NHS GGC to review the following:

> "(a) Changing of 4No. PPVL isolation rooms (17,18,19 & 20) within Ward 2A to positive pressure isolation rooms for the continued use for transplant and severely immune-compromised patients.
>
> (b) Review of PPVL isolation rooms (43 & 44) within Adults ICU for compliance against HBN 04-01 Supplement 1 (Base Build Specification). However SHPN 04 Supplement 1 will be utilised as this is specific guidance for Scottish Healthcare Facilities. Where any differences are evident these will be identified in bold italics).
>
> (c) Review 2No. Isolation rooms (5 & 12) within PICU and provide comment on compliance.
>
> (d) Coordinate with Department of Health to assist with obtaining confirmation on what Hazard Classification of patient can be nursed within PPVL Isolation Rooms that comply with SHPN/HBN 04-01 Supplement 1".[255]

11.17 H&K state that isolation rooms without ensuite facilities are "common in hospital departments where the patient group would be unable to utilise en-suite facilities due to their state of health e.g. intensive care".

11.18 H&K state that "All of the facilities are provided with dedicated supply air handling units partnered with dedicated extract systems".

[254] **A32310951** - QEUH Isolation Rooms Report 2016 – Ian Storrar, HFS - Bundle 13 - Witness Statements - Page 601
[255] **A41602399** - Hulley & Kirkwood Isolation Room Review - QEUH and RHC Isolation Rooms Review Rev1

11.19 Other items relevant to the isolation rooms without ensuites which H&K noted as “requirements that are either not evident within the installations or are contrary to the guidance” were:

- […]

a) “The ventilation plant configuration and duty capability is generally in compliance with HBN 04: Supplement 1 however there is no evidence that the supply systems were commissioned taking into consideration the future pressure drop when a Hepa filter would be inserted”.

b) “Excessive access hatches have been installed on the supply and extract ductwork. This is contrary to clause 4.15”.

c) “There appears to be no provision for a gas tight shut off damper or spectacle plate on the extract systems prior to the extract fans. This is contrary to clause 4.14. (Note that al survey of above ceiling runs was not achievable due to operational issues)”.

d) “There are no audio and visual alarms located outside the room lobbies to warn staff of unsafe conditions. This is contrary to clause 4.22”.

e) “There is no provision for a common alarm panel located at the nurse station. This is contrary to clauses 4.6 and 4.22.”

f) “The supply and extract duct access hatches have not been identified as a bio-hazard. This is contrary to clauses 4.15 and 4.19”.

g) “The supply and extract plant and duct systems have not been identified with the rooms that they serve. This is contrary to clauses 4.15 and 4.19”.

h) “Where safe change filter housings have been provided as opposed to vertical discharges they have not been installed external to the building. This is contrary to clause 4.16. Fire compartmentation strategy will require reviewed taking the above into consideration”.

i) “The existing dial pressure gauges monitoring lobby positive pressure are inappropriate for monitoring a 10Pa pressure differential. 30-0-30 Pa is preferred as what has been installed within PICU”.

j) “No envelope permeability test carried out”.

11.20 With specific reference to two isolation rooms in PICU as examples (rooms 5 and 12), other potential issues noted were:

a) “Although ceiling voids could not be accessed within the rooms it was evident that final connections to grille boxes was by the use of flexible ductwork in lieu of a bend. This is non-compliant to SHTM 03-01 A – Section 5.55”
b) “It was not clear what patient group the rooms were being utilised for however as compliance with SHPN 04 – Supplement 1 had not been achieved this guidance cannot be utilised”.
c) “The isolation suite lobbies are fitted with magnahelic gauge to allow a visual identification of the lobby to corridor pressure. Which is nominally 10pa+ve. No alarm has been installed locally or repeated at the PICU nurse station. This means that key monitoring conditions such as door left /held open, pressure failure will not be known until the nursing staff have reason to visit the room”.
d) “The door between the lobby and isolation room opens inwards so the air flow from the lobby tends to keep it open. It should have been hung the other way so that the air flow tends to shut it.”
e) “No door closers fitted to ‘any’ doors”.

Instruction of remedial works

11.21 A ‘SBAR action plan’ compiled a list of 27 issues identified in multiple wards and stated their respective positions as at 5 December 2017, including:

Issue 1: “PPVL rooms not compliant with SHTM standards Critical Care”

Position as of December 2017: “Facilities colleagues confirmed that there are 10 air changes per hour and a positive pressure of 10 pascals in the PPVL rooms which is consistent with SHBN 04-01”.

Issue 2: “PPVL rooms do not provide appropriate protection for patients with infectious diseases of high consequence (IDHC) e.g. MERS, SARS. This issue also exists in the Royal Hospital for Children”.

Position as of December 2017: “IDHC should be nursed in negative pressure rooms. These are not available in QEUH. In order to address this issue in the short term a patient pathway has been agreed by the Infectious Disease (ID) Clinicians whereby patients will be routed either to GRI or Lanarkshire ID unit. Chief Nurse (CN) for Paediatrics discussing with clinical teams a pathway for children”.

Future actions: “Heath Protection Scotland (HPS) have been sent information on these rooms and we await their advice on whether they can be used for patients with IDHC or if not what actions could be taken to modify these rooms to provide negative pressure. This advice was sought in 2016 & 17”.

Issue 6: “HEPA filters in PICU for the protection of patients in the Bone Marrow Transplant Unit (BMTU) that might need critical care during treatment. The BMTU is ward also referred to as ward 2A”.[256]

Position as of December 2017: “HEPA filters were installed within PICU/Ward 2a week commencing 6 November 2017, within room numbers 12 and 17 – previously installed within room 18. HEPA filter still to be fitted in room 5 (access to be agreed with clinical colleagues)”.

11.22 In February 2018, Lead ICD Teresa Inkster produced another SBAR titled ‘Airborne infection, RHC, patient pathway’, which stated:

“PPVL rooms are situated throughout RHC. A review of these facilities in the adult hospital has suggested they are unsuitable for airborne

[256] **A38759222** - SBAR – Multiple Wards – Action Plan - January 2019

infections. Work is ongoing with input from HPS and HFS with a view to upgrading to negative pressure facilities. These PPVL rooms are suitable for other infections not spread via the airborne route and for isolation of immunocompromised patients".[257]

11.23 The recommendations for the childrens hospital were to:

"1) Nurse paediatric patients with MERs CoV in one of the two PPVL rooms in CDU, RHC. Implement appropriate IC precautions as per policy.
2) Nurse patients with Chickenpox or Measles in any PPVL room in RHC (not 2A). Implement appropriate IC precautions.
3) MDRTB – individual risk assessment by paediatric ID Consultant. Older children may be transferred to MDGH or GRI as per adult pathway. Younger children should be admitted to any PPVL rooms in RHC (not 2A) with appropriate IC precautions in place .
4) Consider upgrade of two PPVL rooms in RHC to negative pressure facilities. One should be in PICU". [258]

11.24 In February 2018, Consulting Engineers Hulley & Kirkwood (H&K) were instructed by NHS GGC Estates to "review the requirements for adapting a typical PPVL isolation suite to a negative pressurised suite". H&K noted in their report that "there does not appear to be any UK NHS guidance on the design of Negative Pressure (NP) isolation rooms", stating however "it is reasonable to take guidance from SHTM 03-01 and in particular the guidance pertaining to operating theatre ventilation system design". They add:

"SHTM 03-01 Part A Table A4 offers advice on air volume flows through doorways between rooms of different cleanliness in order to control cross-contamination. The table advises that an air flow of 0.28m3/s is

[257] **A32342096** - SBAR dated February 2018, RHC -airborne infection (February 2018) - Bundle 4 - NHS Greater Glasgow and Clyde: Situation, Background, Assessment, Recommendation (SBAR) Documentation - Page 121
[258] **A32342096** - SBAR dated February 2018, RHC -airborne infection (February 2018) - Bundle 4 - NHS Greater Glasgow and Clyde: Situation, Background, Assessment, Recommendation (SBAR) Documentation - Page 121

adequate to offer protection to a single doorway between a room and another one level lower in the hierarchy of cleanliness. With reference to SHTM 03-01 Part A Table A2, if one assumes the patient bedroom to be 'Sterile', the lobby as 'Clean' and the ward corridor as 'Transitional' then it can be concluded that a cascading air flow from the ward corridor to the isolation room at a rate of 0.28m3/s is adequate to prevent cross-contamination".[259]

11.25 H&K's proposed modifications to PPVL rooms to create a negative pressure isolation room were to:

- Relocate primary conditioned supply currently located in lobby to corridor immediately adjacent to the proposed room, and re-balance to achieve negative pressure in lobby and room in relation to corridor.
- Adjust set points at AHU such that conditioned air delivered is matched to that set for the nurses base I corridor areas.
- Introduce wall mounted 4 pipe fan coil unit (recirculation) within room to provide room temperature control of heating and cooling
- Retain pressure stabiliser damper between lobby and isolation room at 5Pa, and install a new pressure stabiliser damper for 5Pa differential between the lobby and ward corridor (target 10Pa negative pressure differential between the isolation room and the ward corridor).
- In some rooms where there is a clinical requirement for low level extract around the bedhead, low level extract will be introduced. Otherwise, extract could remain the same.
- Extract terminals to be replaced with terminals with integrated volume control dampers that can be accessed from below through the grilles. This is so that existing duct mounted volume control dampers and their associated ceiling access hatches could be removed.
- Existing dial pressure gages to be replaced with gauges with a -30/0/30Pa scale and the room side impulse tube relocated from the lobby to the

[259] **A41602403** - RHC Ward 2A Isolation Rooms Tender - May 2017

isolation room to give visual indication of the maintained negative pressure within the corridor to isolation room."

11.26 H&K noted that the introduction of a fan coil unit (FCU) could be a disadvantage because:

- It would require intrusive works for routing of pipework, condensate, drainage sealing of services etc.
- Additional maintenance and cleaning/decontamination procedures would be required
- No fresh filtered air would be supplied to the isolation room, rather supply air would be entrained and recirculated from the corridor.

11.27 On 21 February 2018 Dr Christine Peters circulated notes of a workshop and discussion group regarding the proposed plans for PPVL conversion. Also in attendance were Ian Powrie (NHS GGC Estates), 'the designers' [Hulley & Kirkwood], Malcolm Thomas (Authorised Engineer and co-author of SHTM 03-01) and Dr Blanca Beato-Arribas (Building Services Research and Information Association (BSRIA)). Dr Peters' notes of the meeting were:

> "I suggest that while it is possible to change the ITU rooms into negative pressure suites some basic questions need to be addressed first:
>
> An overarching organisational plan for isolation of:
>
> 1. Non critically ill patients with cat 3 airborne infections - is ITU the best place for them?
> 2. Critically ill patients with Cat 3 organisms - negative pressure suite provision, needs clear differentiation from PPVL rooms in terms of instructions and staff training
> 3. Potential cat 4 patients which are non-airborne, or are potentially airborne - of course this is more a national discussion in terms of any new unit specs.
> 4. A+E/ Admissions unit isolation facilities

5. ID unit
6. Immune compromised patients who need critical care or rare infectious
o These questions relate to both adult and children hospitals
o An entrance on the risk register of the shortcomings of the PPVL rooms we have with regard to air mixing (may find its ok on BSRIA testing, but dubious) need for removal of dampeners, provision of alarms, fixing of baffles, rebalancing of extract in toilet, doors being hung wrong way.
o Need for a scoping exercise for changes to ventilation for some areas-, CF, ID ? Haemonc? renal transplant - including the cheapest and easiest option of ducts being external to the building as suggested by Malcolm
o Need for the GRI room to be replaced if it is correct that it is still one that has 2 modes".[260]

11.28 On 23 April 2018, Dr Teresa Inkster, Lead Infection Control Doctor emailed colleagues in NHS GGC and H&K stating that she was "happy to sign off these plans from an infection control perspective". [261]

11.29 Seven rooms throughout the hospital were selected for conversion to negative pressure. Three of those were in the RHC, including PICU bed 5.[262]

11.30 A programme of work was developed, with the conversion of PPVL rooms in the children's hospital ('Phase 2') scheduled to begin on 5 November 2018.[263] However there were delays to the programme due to issues with Phase 1 works (Adult HDU rooms).[264]

[260] **A49377179** - Email from C Peters, T Inkster, I Powrie regarding PPVL rooms workshop and meeting - 21 to 27 February 2018
[261] **A49377176 -** Email from T Inkster consenting to conversion of PPVL Isolation Suite to Negative Pressure - 24 April 2018
[262] **A38759222** - SBAR – Multiple Wards – Action Plan - January 2019
[263] **A49377178 -** Emails between T Mills, A Traquair Smith, Regarding Isolation Rooms - Phase 1 Handover - 29 October to 5 November 2018
[264] **A49377174** - Email between T Mills A Traquair Smith, T Inkster regarding Isolation Rooms - Phase 1 Handover - 9 to 13 November 2018

11.31 By 5 December 2018, a number of concerns were raised at an update meeting with estates, capital planning and clinical staff in attendance:

- “The fans applied to the duct work in the adult ITU rooms which allow negative pressure to be generated are working at full capacity and are not achieving the desired negative pressure requirements. Initial thoughts were that this was due to leaks in the duct work however this is seeming less likely and there is little confidence that new fans will fix the problem. Meantime, the rooms as you know, must not be used for any patients requiring TBPs.

- It was initially reported at the start of the meeting that there was a level of confidence that the RHC rooms currently closed for the same works, would meet validation requirements as the duct work appears very different. A report received during the meeting confirmed that these rooms are not achieving the desired negative pressure requirements and in fact are achieving even lower rates of negative air pressure than the adult site.

- The remaining phase of works to upgrade rooms has now been halted as clinical colleagues are not willing to close off any further beds to allow works to go ahead when the problem from the previous phases has not yet been identified.

- There are concerns that the flow of air in all other lobbied rooms in the hospital is not adequate for infectious patients and as a result it was voiced that there is a risk that infectious particles from within these rooms may have been disseminated into the main wards. Capital planning colleagues raised concern that the rooms occupied by Ebola and MDR TB patients in the adult hospital may not have provided adequate protection. Furthermore, there are concerns that the duct

work is now contaminated and as a result they are keen to fog the duct work to ensure that no contamination, if any, remains".[265]

11.32 While issues with the conversion were resolved and works halted, the isolation rooms affected were re-opened for use as standard (non-isolation) rooms, without HEPA filtration. Concerns were raised by the NHS GGC Estates team, who advised that using the rooms without extract HEPA filters while the distance of extract ventilation from the building façade was non-compliant, was against building regulations. Instead, Estates suggested the HEPA filters were reinstated and the pressure alarms disabled, stating "The only reason we didn't want the filters installed was that we knew there was a risk the pressure alarms were likely to go off as soon as the HEPA filters got dirty and restricted air flow".

11.33 Ultimately the decision to recommission the isolation rooms as conventional ward bedrooms over the winter period was taken:

> "Due to the urgent need to get beds back into the system, these rooms in the interim would not be used as isolation rooms but regarded as standard single room accommodation. The guidance cited relating to isolation rooms therefore largely becomes irrelevant for this interim arrangement and HEPA filtration would not be required.
>
> The background for removing the filters was based on two main points:
> 1. The existing plant is not and unlikely to have ever been capable of providing long term isolation room air flow parameters. This is contrary to the-information provided within the building's O&M's and original commissioning data.
> 2. The as fitted installations have no pre-filtration protecting of the HEPAs and there is significant concern the filters would rapidly deteriorate resulting. in ·air flow reductions affecting a negative pressure environment causing regular alarms and necessitating the HEPAs to be replaced frequently. The regularity of this is unknown,

[265] **A49377175** - Email from S Dodds to T Inkster regarding Negative pressure rooms and concerns relating to other lobbied rooms on QEUH RHC site - 5 December 2018

> however, it is estimated it could possibly be weekly depending on environmental conditions. Additionally, there is no spare capacity within the system to increase the air flow i.e. the fan inverters are already running at their maximum. ·
> On this basis it was agreed the rooms, pending the final ventilation remedial solution, would not be used for patients requiring isolation but would in the interim revert to standard rooms, collectively it was agreed the HEPA filters could be removed mitigating the issues described above and facilitating conventional room use. The air changes within the rooms cannot be guaranteed should these filters be reinserted and we would have no way of knowing when critical levels have been reached if the alarms are disconnected, it would not be our recommendation to adopt this approach as we believe even Building Standards air change rates could potentially be breached under such circumstances.
>
> Infection Control correctly will not sign off on these rooms being used for isolation and that's not the intent here, but Teresa lnkster has accepted their use for patients who do not have airborne infection or immunosuppression".

11.34 Project supervisors with the capital planning team advised the estates team that the solution would only be provided on a temporary basis, adding: "The design work remains ongoing to provide a solution to meet the negative pressure isolation room requirement for infectious patients. This work will be delivered early next year with the exact timescale to be confirmed once a design solution for the extract system has been agreed".[266]

11.35 By 28 May 2019, Lead ICD Teresa Inkster emailed NHS GGC Estates colleagues to arrange the next steps following completion of the negative pressure conversion works:

[266] **A49377180** - Emails between S Russell, I Powrie, A Wilson, A Gallacher, D Conner regarding isolation rooms - Commissioning delay - 28 November to 4 December 2018

> "Whilst we now have negative pressure rooms for infectious patients we are still using these PPVLs for immunosuppressed patients for which there was an exclusion in the guidance. Cracks in the fabric and holes can be an issue depending on the extent as the premise for these rooms is that they are sealed.
> It would also be useful to discuss how many of the remainder were built with modifications on the original design and whether there is anything we can do about that. I note a latent defect in this particular report [Ward 2C Room 5].
> I have attached the HFS report into these rooms for discussion on Friday".[267]

11.36 An 'Isolation room steering group' was set up, with the first meeting on 31 May 2019. The Inquiry has not had sight of the minutes of those meetings.

11.37 By May 2019, Isolation Room No. 5 had been converted to a Negative Pressure Isolation room with the other 3 isolation rooms remaining as PPVL isolation rooms.

11.38 NHS GGC have advised the Inquiry that, other than the changes to the supply and extract to convert room 5 to a negative pressure room and the installation of HEPA filtration, no physical changes have been made to the ventilation system serving the PICU isolation rooms since handover in 2015.[268]

12. Clinical Decision Unit

12.1 The Clinical Decision Unit is located on the Ground floor. At handover 2 PPVL rooms were provided – Bed 17 and Bed 18.

[267] **A49377177** - Emails between T Inkster and D Conner regarding Isolation room verification reports - 23 May to 26 August 2019
[268] **A46059364** - NHSGGC response to RFI '05 a) & c) Isolation Rooms RHC updated'

12.2 In July 2023, the Section 21 response from NHS GGC, confirms that at handover no validation was carried out on these rooms.[269]

Upgrade works

12.3 HEPA filtration was recorded in Bed 17 in August 2021.

12.4 HEPA filtration was recorded in Bed 18 in September 2018

12.5 In May 2019 Bed 18 was converted from a PPVL isolation room to a Negative Pressure Isolation Room. The Section 21 response from NHS GGC, dated July 2023 confirms the upgrade works as:

> "The ventilation system changes were the installation of a supply grille in the patient room and an extract grille in the lobby. These were additional to the existing grilles. The system was then re-balanced to ensure the flow of air is always from the corridor or lobby to the patient room. Within the plant rooms, gas tight dampers were fitted to both supply and extract ductwork allowing them to be sealed for disinfection if required".[270]

13. Cardiology Ward

13.1 The Cardiology Ward is located on level 1 and there are 2 isolation rooms located in this ward. The COS for Cardiac Services refers to:

> **"**<u>Inpatient ward area</u>
> The there will be a 14 bed unit which will be adequate for the current level and pattern of service and can accommodate spikes in activity. 1 open areas of 4 beds located close to the central nurses station would facilitate the close monitoring required by patients returning from

[269] **A44943356** - S.21 response from GGC regarding Validation
[270] **A44943477** - S.21 response from GGC July 2023, '05 a) and c) Isolation Rooms RHC'

> intensive care and cardiac catheterisation procedures. A further 10 cubicles would then allow isolation of patients to prevent the spread of infection, to protect immunologically compromised children and to help nurture parent/baby relationships in the convalescent phase of care".

13.2 Under Building Requirements there is no mention of any ventilation requirements for the ward. The only reference is made to the laboratory with notes that it "should be built to operating theatre specifications including positive atmospheric pressure and temperature control.".

13.3 At handover both of these isolation rooms were PPVL and they remain PPVL.

13.4 In July 2023, the Section 21 response from NHS GGC, confirms that at handover no validation was carried out on these rooms.[271]

Upgrade works

13.5 The Section 21 response from NHS GGC, dated July 2023 confirms the upgrade works as:

> "The verification report for CAR 016 records that in September 2018 a terminal HEPA filter was present in the lobby supply grille. There have been no further changes to this ventilation system.
> The verification report for CAR 011 records that in September 2018 a terminal HEPA filter was present in the lobby supply grille. There have been no further changes to this ventilation system".[272]

14. Acute Receiving Ward

[271] **A44943356** - S.21 response from GGC regarding Validation
[272] **A44943477** - S.21 response from GGC July 2023, '05 a) and c) Isolation Rooms RHC'

14.1 Ward 2C is the Acute receiving ward, located on level 2. The COS for the Generic Inpatient wards in the RHC confirms the following:

> "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". [273]

And under 'General Points' refers to:

[273] **A35761946** - NSGACL GENERIC WARD NCH_iss2_rev' - Bundle 16 - Ventilation PPP - Page 1652

> "2 rooms per ward will be used for isolation purposes and will have an associated gowning lobby".[274]

14.2 At handover 2 PPVL's were provided – one of the rooms was changed in May 2019 to an NPIR.

14.3 In July 2023, the Section 21 response from NHS GGC, confirms that at handover no validation was carried out on these rooms.[275]

Upgrade Works

14.4 Section 21 response from NHS GGC, dated July 2023 confirms the upgrade works as:

> "In May 2019 ARU 109 [Bed 6] was converted from a PPVL to a NPIR at the request of Consultant Physicians and ICD's. The ventilation system changes were the installation of a supply grille in the patient room and an extract grille in the lobby. These were additional to the existing grilles. The system was then re-balanced to ensure the flow of air is always from the corridor or lobby to the patient room. Within the plant rooms, gas tight dampers were fitted to both supply and extract ductwork allowing them to be sealed for disinfection if required".[276]

15. Level 3 Isolation Rooms

15.1 Ward 3A is the Neurology, Neurosurgery, Complex Airway/LTV, Endocrine and Metabolic ward. At handover 2 PPVL Isolation Rooms were provided.

15.2 In July 2023, the Section 21 response from NHS GGC, confirms that at handover no validation was carried out on these rooms.[277]

Upgrade Works

[274] **A35761946** - NSGACL GENERIC WARD NCH_iss2_rev' - Bundle 16 - Ventilation PPP - Page 1652
[275] **A44943356** - S.21 response from GGC regarding Validation
[276] **A44943477** - S.21 response from GGC July 2023, '05 a) and c) Isolation Rooms RHC'
[277] **A44943356** - S.21 response from GGC regarding Validation

15.3 The Section 21 response from NHS GGC, dated July 2023 confirms the upgrade works as:

> "The verification report for GW3 053 (Bed 16) records that a terminal HEPA filter was not present in the lobby supply grille until April 2022. There have been no further changes to this ventilation system.
> The verification report for GW3 054 (Bed 15) records that in September 2018 a terminal HEPA filter was present in the lobby supply grille. There have been no further changes to this ventilation system".

15.4 Ward 3B is the Gastroenterology / ENT / Surgical Ward. At handover 1 PPVL Isolation Room was provided.

15.5 In July 2023, the Section 21 response from NHS GGC, confirms that at handover no validation was carried out on these rooms.[278]

Upgrade Works

15.6 The Section 21 response from NHS GGC, dated July 2023 confirms the upgrade works as:

> "The verification reports for GW2 022 (Bed 19) records that a terminal HEPA filter was not present in the lobby supply grille until April 2020. There have been no further changes to this ventilation system".

15.7 Ward 3C is the Orthopaedics/Renal including dialysis/Rheumatology Ward. At handover 3 PPVL Isolation Rooms were provided.

15.8 In July 2023, the Section 21 response from NHS GGC, confirms that at handover no validation was carried out on these rooms.[279]

[278] **A44943356** - S.21 response from GGC regarding Validation
[279] **A44943356** - S.21 response from GGC regarding Validation

Upgrade Works

15.9 The Section 21 response from NHS GGC, dated July 2023 confirms the upgrade works as:

> "The verification report for GW1 055 (Bed 9) records that in October 2018 a terminal HEPA filter was present in the lobby supply grille. There have been no further changes to this ventilation system.
> The verification report for GW3 058 (Bed 10) records that in March 2019 a terminal HEPA filter was present in the lobby supply grille. There have been no further changes to this ventilation system.
> The verification report for GW2 055 (Bed 5) records that a terminal HEPA filter was not present in the lobby supply grille until July 2020. There have been no further changes to this ventilation system".

Appendix

Table showing Isolation Rooms in the QEUH and works undertaken following handover in 2015

Isolation Rooms - QEUH												
Location	Ward Type		2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Level 1	High Dependency Unit (HDU)	Bed 11	PPVL	PPVL	PPVL	PPVL	PPVL(*Feb)	PPVL	PPVL	PPVL	PPVL	PPVL
		Bed 50	PPVL (* Sept)	PPVL	PPVL	PPVL	PPVL	PPVL	PPVL	PPVL	PPVL	PPVL
		Bed 3	PPVL	PPVL	PPVL	PPVL	PPVL	PPVL	PPVL (*June)	PPVL	PPVL	PPVL
		Bed 4	PPVL	PPVL	PPVL	PPVL	NPIR	NPIR	NPIR	NPIR	NPIR	NPIR
		Bed 43	PPVL	PPVL	PPVL	PPVL	NPIR	NPIR	NPIR	NPIR	NPIR	NPIR
Level 1	Intensive Care Unit (ICU)	Bed 40	PPVL	PPVL	PPVL (* April)	PPVL	PPVL	PPVL	PPVL	PPVL	PPVL	PPVL
		Bed 31	PPVL (* Sept)	PPVL	PPVL	PPVL	PPVL	PPVL	PPVL	PPVL	PPVL	PPVL
		Bed 23	PPVL	PPVL	PPVL	PPVL	PPVL (* June)	PPVL	PPVL	PPVL	PPVL	PPVL
		Bed 24	PPVL	PPVL	PPVL	PPVL	NPIR	NPIR	NPIR	NPIR	NPIR	NPIR
		Bed 44	PPVL	PPVL	PPVL	PPVL	NPIR	NPIR	NPIR	NPIR	NPIR	NPIR
Level 4	Renal	Bed 19	PPVL	PPVL	PPVL	PPVL	PPVL	PPVL	PPVL	PPVL	PPVL	PPVL
		Bed 20	PPVL (* Sept)	PPVL	PPVL	PPVL	PPVL	PPVL	PPVL	PPVL	PPVL	PPVL

Key	
PPVL	Positive Pressure Ventilated Lobby
NPVL	Negative Pressure Ventilated Lobby
PPIR	Positive Pressure Isolation Room
NPIR	Negative Pressure Isolation Room
*	HEPA Filtration added

Table showing Isolation Rooms in the RHC and works undertaken following handover in 2015

Isolation Rooms - RHC												
Location	**Ward Type**	**Bed Reference**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**
Ground Floor	Clinical Decision Unit	17	PPVL	PPVL	PPVL	PPVL	PPVL	PPVL	PPVL (*Aug)	PPVL	PPVL	PPVL
		18	PPVL	PPVL	PPVL	PPVL	NPIR (May)	NPIR	NPIR	NPIR	NPIR	NPIR
Ward 1D	Paediatric Intensive Care Unit (PICU)	5	PPVL	PPVL	PPVL	PPVL	NPIR (May)	NPIR	NPIR	NPIR	NPIR	NPIR
		12	PPVL	PPVL	PPVL	PPVL	PPVL	PPVL (*July)	PPVL	PPVL	PPVL	PPVL
		17	PPVL	PPVL	PPVL	PPVL	PPVL	PPVL (*Nov)	PPVL	PPVL	PPVL	PPVL
		18	PPVL	PPVL	PPVL	PPVL	PPVL	PPVL (*June)	PPVL	PPVL	PPVL	PPVL
Ward 1E	Cardiology Ward	13	PPVL	PPVL	PPVL	PPVL	PPVL	PPVL	PPVL	PPVL	PPVL	PPVL
		14	PPVL	PPVL	PPVL	PPVL	PPVL	PPVL	PPVL	PPVL	PPVL	PPVL
Ward 2A	Peadiatric Bone Marrow Transplant Unit	17	PPVL (*June)	PPVL	PPVL	PPIR	PPIR	PPIR	PPIR	PPIR	PPIR	PPIR
		18	PPVL (*June)	PPVL	PPVL	PPIR	PPIR	PPIR	PPIR	PPIR	PPIR	PPIR
		19	PPVL (*June)	PPVL	PPVL	PPIR	PPIR	PPIR	PPIR	PPIR	PPIR	PPIR
		20	PPVL (*June)	PPVL	PPVL	PPIR	PPIR	PPIR	PPIR	PPIR	PPIR	PPIR
		22	PPVL (*June)	PPVL	PPVL	PPVL	PPVL	PPVL	PPVL	PPVL	PPVL	PPVL
		23	PPVL (*June)	PPVL	PPVL	PPVL	NPVL (May)	NPVL	NPVL	NPVL	NPVL	NPVL
		24	PPVL (*June)	PPVL	PPVL	PPVL	PPVL	PPVL	PPVL	PPVL	PPVL	PPVL
		25	PPVL (*June)	PPVL	PPVL	PPVL	PPVL	PPVL	PPVL	PPVL	PPVL	PPVL
Ward 2C	Acute Receiving Ward	5	PPVL	PPVL	PPVL	PPVL	PPVL	PPVL	PPVL	PPVL (*May)	PPVL	PPVL
		6	PPVL	PPVL	PPVL	PPVL	NPIR (May)	NPIR	NPIR	NPIR	NPIR	NPIR
Ward 3A	Neurology, Neurosurgery, Complex Airway/LTV, Endocrine and Metabolic	15	PPVL	PPVL	PPVL	PPVL (*Sept)	PPVL	PPVL	PPVL	PPVL	PPVL	PPVL
		16	PPVL	PPVL	PPVL	PPVL	PPVL	PPVL	PPVL	PPVL (*April)	PPVL	PPVL
Ward 3B	Gastroenterology / ENT / Surgical Ward	19	PPVL	PPVL	PPVL	PPVL	PPVL	PPVL (*April)	PPVL	PPVL	PPVL	PPVL
Ward 3C	Orthopaedics/Renal including dialysis/Rheumatology	5	PPVL	PPVL	PPVL	PPVL	PPVL	PPVL (*July)	PPVL	PPVL	PPVL	PPVL
		9	PPVL	PPVL	PPVL	PPVL (*Oct)	PPVL	PPVL	PPVL	PPVL	PPVL	PPVL
		10	PPVL	PPVL	PPVL	PPVL	PPVL (*March)	PPVL	PPVL	PPVL	PPVL	PPVL

Key	
PPVL	Positive Pressure Ventilated Lobby
NPVL	Negative Pressure Ventilated Lobby
PPIR	Positive Pressure Isolation Room
NPIR	Negative Pressure Isolation Room
*	HEPA Filtration added

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 26 – Provisional Position Papers

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