SCOTTISH HOSPITALS INQUIRY

Hearings Commencing
19 August 2024

Day 6
Tuesday, 27 August 2024
Dr Thomas Makin
Mr Dennis Kelly

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10:04

THE CHAIR: Good morning. The witnesses today will be taken by Mr Maciver and I think our first witness is Dr Makin.

MR MACIVER: Yes, Dr Thomas Makin, my Lord.

THE CHAIR: Good morning.

THE WITNESS: Good morning.

THE CHAIR: As I think you appreciate, you're about to be asked questions by Mr Maciver, who's sitting opposite to you, but first I think you're prepared to affirm. Is that correct?

THE WITNESS: Yes, it is.

Dr THOMAS MAKIN

Affirmed

THE CHAIR: Thank you. Now, on timing, we anticipate your evidence might take much of the morning. We usually take a break at half past eleven or so for coffee. However, if, at any time, you want to take a break, just give me the indication and we'll take a break.

THE WITNESS: Thank you.

THE CHAIR: Now, Mr Maciver.

Questioned by Mr MACIVER

MR MACIVER: Good morning.

A Good morning.

Q Could you tell the Inquiry your name, please?

A It's Dr Thomas Makin.

Q And I gather that you're involved in a company called Makin and Makin Consultancy Limited.

A That's correct.

Q Could you tell us in broad terms what are its activities?

A What, sorry?

Q What are the company's activities?

A Activities, yes? We are a company that provides advice to any organisation, normally healthcare premises, with regards to quality of water, so we are consultants that advise on water quality and water quality issues.

Q Thank you, and what's your role within the company?

A I'm a director within the company.

Q Now, you've provided a statement to the Inquiry and you've signed that and, if necessary, we will just have a copy of that up on the screen. You may have brought your own copy with you to use.

A Yes.

Q That's fine. Now, I understand that you may also have your own copies of some of the documents that were on the document list----

A Yes.

Q -- either physically or electronically.

A Both.

Q Okay. Well, could I ask you-- I see there's a laptop next to you.

A Yes.

Q Could I ask you to just keep the laptop closed for the moment?

A Yes.

Q Where I refer to documents, it will be brought up on screen. So, the big screen in front of you will have a copy of that, so we should be able to work from that, but if not, do let me know at any point.

A Yes. The only reason why I asked for the laptop here is because I've appended notes to some of these documents on here which were aide-memoires for me, really, but I may or may not need them.

Q Thank you. Well, you mentioned your statement a moment ago. Just at the outset, can I ask you to confirm that you're happy to adopt the statement as your evidence to the Inquiry?

A Yes, I'm happy with that, yes.

Q At question 1 of the statement, you were asked about your history of education and working with the NHS. That will be page 3 of the statement. Now, your first paragraph mentions you starting out in 1968 and the second paragraph mentions your retirement in 2010, and there are a host of roles in between. Does this reflect a full career with the NHS, or were you working elsewhere for spells?

A Sorry, at which point?

Q Between '68 and 2010, was that a full career spent with the NHS, or were you working in other places during that time?

A No, it was a full career with the NHS, yes.

Q And Makin and Makin was established in 2007, as I understand it.

A Yes.

A And therefore that's in the context for your activities post retirement.

A That's right.

Q Now within Question 1, you've mentioned two specific areas of your work. The first one is your involvement with Legionella. You mention, if we move on-- if we scroll on to the next page, you mention there investigations or written output that you undertook in a number of years; there's 1979, 1995, 2001, 2016, among others. This has been a constant feature in your career dealing with Legionella, is that correct?

A Yes, it is. Yes, yes.

Q And, indeed, you also give us a bit of history by describing it being discovered in 1976.

A Yes.

A And does it follow from that it's a matter you've kept abreast of your entire career?

A Yes, yes. I've been very interested in it since-- As I mentioned in the statement, there was an outbreak in the hospital where I worked, and I think it was the first recorded outbreak of Legionnaires' disease in the UK, and so, as a microbiologist, I got involved in it and it interested me ever since.

Q So, by this time, you've built up considerable expertise in Legionella control?

A Yes, I think I was probably one of the first in the country to actually get involved in Legionella and trying to recover that organism from water systems.

Q The other specific thing that you mention on this page is your involvement in Pseudomonas.

A Yes.

Q You mention having assisted the Department of Health in producing a Pseudomonas addendum to the HTM 04-01 guidance.

A Yes.

Q And that's at the foot of that page. I think that arose in the course of your other work producing and updating that guidance, is that correct?

A Yes, it is, yes.

Q Just for clarity, are Legionella and Pseudomonas separate areas of expertise, or are they all of a piece with your activities in microbiology?

A They are very similar organisms in many ways. They are what's known as gram-negative bacteria, so they are rod-shaped bacteria that live in water systems, and so they have very many similar features within water systems. They like to grow within biofilm, for instance, and so it's appropriate to look at both of those organisms as water-borne pathogens.

Q And is dealing with those among the specialisms of what you do with Makin and Makin?

A It is. It is, yes.

Q Right. If we move on a couple of pages to page 6 of the statement bundle, here at the foot, you are talking about your-- or you're asked about your initial involvement with QEUH. Can I ask you, who approached you and how were you approached to work with QEUH?

A The very first approach was by a gentleman called Ian Storrar, who was the principal engineer for Health Facilities Scotland. I think Mr Storrar may have been present at some of the lectures I'd given – either up in Scotland or up in the North East of England – and he approached me via LinkedIn, strangely, and then asked me if I would contact a colleague of his at the hospital, which I

did, and it started from there. So the initial contact was Ian Storrar.

Q You say, "Strangely through LinkedIn." Is that a relatively informal approach in the world of NHS consultancy?

A Yes. I was quite surprised by it because I don't normally use LinkedIn, really. It's just something you see chats on and so on and sometimes there's interesting chats going on around water quality issues, but he contacted me-- Because most people, if they want me, would either phone me or contact me by email, so LinkedIn was a strange way to get in touch, really, but it was okay.

Q You mentioned that Ian Storrar had a role with, I think you said NHS Facilities Scotland.

A Yes.

Q Was that dedicated to the Queen Elizabeth Hospital, do you know, or was it a wider-ranging role?

A I think it was a wider range, yes. Yes.

Q And he was the person that-- did you speak to him, or was it contact simply over LinkedIn?

A It was LinkedIn contact. Yes, I don't believe I did speak to him, no. I have met him previously, yes, and, as I say, I may have met him at some of these lectures I was giving, but no, it was LinkedIn which started the process.

Q And was that an exchange of messages over LinkedIn, or was it one communication to you?

A Yes. As I recall, he contacted me and I think I must have responded, yes, because he asked me to get in touch with Ian Powrie at the hospital, which is what I did, but I must have answered him, yes, so it must have been through LinkedIn again.

Q And do you recall, at this time, was that the extent of the discussions or did you discuss any details about the (inaudible – overspeaking)?

A No, there was no detail and, in fact, I remember there was a distinct absence of detail at that point, really, yes, but I was obviously meant to get in touch with either Ian Powrie and be filled in on the detail by him and not by Ian Storrar, yes, who just sort of gave me an outline of what the issue was, yes.

Q Did you understand at that point that this was going to be an actual formal instruction to do work for the Queen Elizabeth Hospital, or was it more speculative?

A At the time when Ian Storrar got in touch with me, I didn't know what it was going to be. He just asked me to get in touch with Ian Powrie and I didn't know the full extent of the problem at that stage or how long they would want me for. So there was a big question mark over that,

but I was quite prepared to give my advice on an ad hoc basis, if necessary, so I got in touch with Ian Powrie.

Q Well, just to freeze things at that point, then, when you've spoken-- communicated with Ian Storrar and before you contact Ian Powrie, how much understanding did you have that would have enabled you to form your own understanding of the nature of the problem at the Queen Elizabeth?

A Before I got in touch with Ian Powrie, you mean?

Q Yes.

A Yes, very little. I would have had hardly any information about what was going on there at that stage.

Q What would your state of knowledge have been?

A State of knowledge about the hospital?

Q In a nutshell, what did you understand you were being asked to do or might be asked to do?

A Well, initially, it was to-- well, clearly, my expertise is in water and contamination of water systems, and so I was being contacted on that basis, and so I knew that I was being required to look at their water systems because they had some sort of problem there. The full extent of the problem I didn't know at that stage, and so I wouldn't find that out until sometime later, and in fact Ian Powrie, when I got in touch with him, provided me with some documents which enlightened me a bit more.

Q Okay, when did you contact Ian Powrie?

A Can I refer to my statement here? Because I can't necessarily remember all the details.

Q Yes, by all means.

A I contacted him by-- Ian Powrie by email on 27 April 2018.

Q And you mention there that that was-- the initial email, followed by a telephone call.

A Yes----

Q From that-- Oh, sorry, go on.

A I was just going to say he phoned me, yes.

Q From that initial exchange, then, what was your understanding of the problem and the extent of it?

A He informed me, as I recall, that they had issues, they had problems. They had isolated organisms from the water system and there were some apparent cases that may be associated with the water system, cases in patients, and he invited me to come up to the hospital and see the size and configuration of the hospital and get a feel for it with a view to advise them on trying to control the issue.

Q You mention in the paragraph below a report relating to contamination.

What was your understanding, if you had an understanding, of the degree of contamination that might be involved?

A Well, the impression I got was that it was quite widespread contamination, so it wasn't just isolated, localised contamination; it seemed to be quite widespread. So there was an issue there, and there was a-- when I got there, I eventually realised it was a big hospital, so that was a heck of a contamination, really, if it was widespread over that size, yes.

Q Okay, I'll come to that in a moment, but at that stage did you have any understanding of what contaminants might be involved?

A Well, it-- contaminants, it would have been microbiological contaminants, yes, microorganisms. I was not particularly aware of which organism was a problem. He may have mentioned Cupriavidus, which was an organism which was isolated from some of the water system and from some of the patients as well. So it was that particular organism which was mentioned first, and then I subsequently discovered that there were quite a lot of other organisms present in the water system.

Q When you did advise the hospital, it was around the idea-- among other things, it was around the idea of chemical treatment of the water.

A Yes.

Q Was that a matter that was raised at that initial stage?

A Possibly. I don't absolutely recall, I'm afraid. Yes, it may have been discussed at that stage, yes. Yes, it could well have been because they were-- the hospital were already thinking about biocide treatment of the water system at that stage, and so he probably would have mentioned it to me, yes.

Q I suppose even if it weren't mentioned to you, given your experience, would it have been a matter that would logically have occurred to you on its own from the information that you got at the initial contact?

A Yes, yes. It was clear that something had to be done about that level of contamination, with it being so widespread, and with it not just being a localised contamination, a more dispersive treatment would be required and so it was clearly heading towards biocide treatment of the water system.

Q Okay, I'm going to ask for a document to be brought up for you, which is the SHTM 04-01 guidance. There's one page that-- it should be at bundle 15, page 337. (After a pause) Now, the-- you're familiar this guidance, I take it?

A Yes-- excuse me, yes, relatively, yes. I was co-author of the HTM in England, yes. This document is

largely taken from that document but with tweaks which sort of apply to Scottish water, really.

Q The reference that I want to take you to is very short. It's the second paragraph on that page, where there is a reference to:

> "The introduction of chemical treatment to the potable water supply is an admission that the physical installation and/or the management process is incapable of maintaining that water supply in a wholesome condition."

Q Is that a fair comment, in your view?

A Not necessarily, no. No, because maintaining the water supply in a wholesome condition-- there's different standards here. "Wholesome condition" is sort of a statement that could mean different things to different people. It depends on how sick you are, really. What you might consider to be wholesome water would be okay for you and I but may not be okay for immunocompromised patients. So there's sort of levels of that definition there, or that statement there, which apply, as far as I'm concerned, yes.

My view is, really, and you'll probably get into this a little bit later-- is that, in many situations now, biocide treatment is required in water systems

more often than we care to think of because-- particularly in healthcare premises, because there's a greater risk there to people who occupy that building and so we have to move the bar a little bit and, maybe, my view is start to introduce biocide treatment a bit earlier in these situations.

Q Okay, that's a matter that I will ask you about later on.

A Yes.

Q But the degree of nuance that you're introducing there is to say that it doesn't follow from the fact that chemical treatment is being introduced or contemplated that we're dealing with an unsafe water system?

A No.

Q And we'll perhaps put that in a wider context, then: are secondary control measures things that would be widely found in hospitals across the UK?

A I would say more and more often, yes. Yes.

THE CHAIR: Sorry, could I ask you to repeat that? My fault entirely. Just-- I didn't quite catch what you said.

A Could you repeat the question, then, please?

Q To put it in its wider context, are secondary control measures widely to be found in hospitals across the UK?

A I would say more and more, yes. Yes, quite a lot of hospitals now use

secondary control measures, yes. You could say that my view on this is a bit selective because I'm brought into hospitals that have problems, and so I would tend to see hospitals that would be using secondary control measures.

Q Are you in a position, then, to say just how frequent they would be, or is it-- is your vision skewed?

A I would only be guessing there, I'm afraid. I would probably not like to hazard a guess there, but certainly the hospitals I go to, many of them end up using secondary control measures.

Q That's fair, thank you. You mentioned that you did an initial visit to the hospital and that was-- if we're back at the statement bundle at the top of page 8, you date that as being 10 May 2018.

THE CHAIR: Sorry, Mr Maciver, can I just check something with Dr Makin? You use the expression "Secondary measures." At least in this current context, is that another way of talking about chemical biocide, the introduction of chemical biocide, or is it a more general expression?

A In this particular case, I'm referring to biocides, the use of biocides.

THE CHAIR: Right.

A But secondary control measures can use things other than biocides----

THE CHAIR: Yes.

A -- such as filters at the outlet, for instance.

THE CHAIR: Right, thank you. Sorry, Mr Maciver.

Q No, thank you, my Lord. Yes, I was going to take you to the initial visit to Queen Elizabeth on 10 May 2018. Now, you've mentioned already that you were-- I don't know if taken aback is the right way to put it, but certainly you were struck by the size of the site, and I think you also say in-- somewhere in this page about the size of the water system----

A I can say that the first thing that struck me when I-- I'd never been to this part of Edinburgh before, and I'd taken the taxi from the train station and I was coming up to the main entrance of the hospital, and I asked the taxi driver what was the building on the right-hand side, as I recall it, which was just before the hospital, and it was a sewage treatment plant. And I was quite astounded by the fact that a hospital should be built right next to the sewage treatment works, which was the first thing, and then the second thing that astounded me was the size, yes.

Q Right, I could deal with those in either order, but I'll perhaps just ask you about the size, first of all.

A Okay.

Q Why did that strike you as being----

A Size?

Q -- yes, worthy of note?

A Well, it's big and you don't often see massive hospitals like that, yes. And I've sort of-- in the many years that I've been working in hospitals, I've come to the view that big is not always beautiful and it's not always more efficient.

Q Does size bring with it problems of its own?

A Yes, definitely, yes.

Q Now, at that first meeting, you mention-- or that first visit, you mention meetings with the incident management team that morning and also with a Dr Hood.

A Yes.

Q Do you recall those? And you say that the IMT was for introductions and to brief you in some of the issues arising in the system. I think, slightly further on-- I don't think we need to go to it, but slightly further on, you mention that, at the IMT, you were asked for your views on a likely source of contamination. Do you recall that?

A Yes, yes.

Q That would be at page 11 of the bundle, if necessary. Can you recall what was said and what did you say?

A As the likely cause of the problem? Yes----

Q Firstly, how considered could your view be at that early stage?

A How considered?

Q Yes.

A Well, I had obviously been in contact with a lot of hospitals and advised them on contamination that they'd had in their water systems, and one of the things that I noticed particularly was a recurrent theme is that, wherever they'd had new builds, where a new hospital was being built or where they were having newly refurbished sections of that hospital, that the problem of contamination-- the water contamination normally occurred then. And so it was a common feature that contamination in the water systems sort of followed on from building works----

Q Yes.

A -- and particularly where there isn't necessarily absolute control over the management of the water system once it's filled with water and even prior to it being filled with water, sometimes it can be open to contamination, but certainly, once water goes into the water system – and that's the tanks and the pipes and the various other components of the water system – then it's immediately a problem in terms of the propensity and the possibility of contamination with microorganisms and then becoming established in that environment. And there are certain things that are required of the people who are building that particular building, and very often, in my

opinion, they don't take on board that responsibility and look after it too well. Some of them do, some of them don't.

Q And this is a pattern that you've seen again and again in your experience?

A Yes.

Q It may be an obvious question to ask, but why did that come to mind at the Queen Elizabeth?

A Because it had just been newly built. It was a newly built hospital, plus it was very big and, as I said, it's got inherent problems. As soon as you have a large system, it's that much more difficult to deal with the water in there because there's miles and miles of pipework with water in it.

Q Right, so it was generally-- the general situation of it being a new build rather than any specific information as to any problems that might have happened in the build?

A Yes.

Q Is that correct?

A Yes, initially, it was the fact that it was a new build and, I think, at that stage, it had only been open three years or something like that, I think, so it was just sort of the right time period. In fact, to a certain extent, slightly delayed. I would have expected the contamination to have been seen a bit earlier.

I can draw on the experiences – my

own experiences – from when we moved into the Royal Liverpool Hospital, University Hospital in Liverpool in 1979, and, within a few months of moving into that new building, we had an outbreak of Legionnaires' disease, and this is what got me into water microbiology. But that showed me that this contamination is very often associated with new build and the poor management of the water system prior to handover to people who will use the building.

Q Thank you. Now, that was, by way of-- something of a digression from the initial question, which was about the discussion at the meeting where you were asked for your views. How did that discussion go?

A Well, it was along the same lines, really, because, obviously, as I'd been given a very sort of quick show around the hospital in the morning-- I think I arrived at about half eight and the meeting was about eleven-ish or something like that, so I had a quick look around the size. I went into the big-- in the basement, I think it was, where the big tanks were, and I saw how big the cold water storage tanks were. They were phenomenally impressive.

THE CHAIR: Right. Just so that I'm keeping up, is this a discussion with Ian Powrie or with others?

A Well, I attended the-- well, a

meeting which was attended by the members of the Incident Management Team and Ian Powrie was there as well.

THE CHAIR: All right.

A Yes.

THE CHAIR: Members of the Incident Management Team?

A Yes, yes.

THE CHAIR: Right, thank you.

A Yes, and it was evident to me that, given the size of the place, that there was going to be issues there. And so, in my discussion with the Incident Management Team – it was-- well, the members there who were at that meeting, which included Dr Hood, who I'd met some years earlier at the Royal Liverpool Hospital – I sort of explained to them my experiences with regards to new builds and how I'm not surprised, really.

The only thing I was surprised about is that it had taken this long to identify it, and one of the things I've mentioned in my statements, which you may come to – but in case you don't, I'll mention it now – is the fact that the Scottish HTM is different from the HTM in some ways. Obviously, you have a very peculiar water-- different water system than we have. Yours is far more corrosive and so on, but----

Q Sorry, when you say "far more corrosive," are you talking about the water itself?

A Yes, yes, which is one of the reasons why you have to have stainless steel pipes in your system in England. Where it's less corrosive, they tend to have copper pipes, yes.

Q Is that simply a matter of geography?

A Yes.

Q Ultimately?

A Who can answer that? Yes, I won't be drawn on that.

Q Right.

A I don't know, really.

Q Well, by geography, I mean, it's different in Scotland. The water is physically differently made up.

A It is. It is. It is more aggressive, generally, yes, but I will say, I mean, it's softer, yes. Well, you'd think the term "softer" would mean gentler. It doesn't; it means the opposite in this case. You know, softer is more aggressive water and we did know about this because, in Liverpool, we have very soft water where the Royal Liverpool University Hospital was, where I worked. They have very soft water there, so there were some similarities in terms of the situation here in Glasgow and my own.

THE CHAIR: Can you help my education? When we talk about softer water, is it more alkali or more acid, or am I talking about the wrong things?

A Yes, it's not necessarily acidity

or alkalinity we're talking about.

THE CHAIR: Right.

A It's sort of calcium hardness, levels of calcium hardness, yes. Yes, so it has less calcium hardness if it's softer.

THE CHAIR: Right.

A Yes----

THE CHAIR: Thank you.

A -- and the pH can be high, so it can all impact on the corrosive properties of the water, yes, which is one of the reasons, as I understand it, why, in Scotland, you tend to go for stainless steel pipes whereas, in England, you tend to see copper pipes more often.

Q That was what I was going to ask you about, that the actual metallic makeup of the pipes is an important matter.

A Yes, yes.

Q Right, so that's specifically when building north of the border rather than south?

A Yes, it is, yes. It's part of the difference, really, yes, but one of the points I was sort of going to make, really, is that the Scottish HTM doesn't advocate testing for the presence of Pseudomonas aeruginosa.

Now, in the HTM 04-01 in England, testing for Pseudomonas aeruginosa, which is an opportunistic pathogen that can infect particularly immunocompromised patients-- the guidance of the English HTM 04-01 is to test on a regular basis – well, six monthly – in every augmented care facility, so augmented care facilities where this extra level of care is given: intensive care units, neonatal units, burns units and so on.

So extra testing is done there on a regular basis to see whether or not the water system is contaminated with Pseudomonas and, if it is, then specific control measures have to be introduced, particularly in those-- (knocks microphone) sorry, I keep hitting it-- in these augmented care units to protect the patients there.

That level of protection, or that level of surveillance, is not required elsewhere in the hospital because there isn't a significant risk to other patients from those particular organisms, but it is in augmented care.

So one of the things about the English HTM is that regular testing is done and you can identify problems because of that regular testing because you will see that there's more Pseudomonas there than should be or you would expect there to be, whereas, in the Scottish HTM where they're not recommending testing for Pseudomonas aeruginosa, they didn't do the early testing that would have been done in England, and so it was maybe three years later that they eventually found the

problem in the water system.

I think, as I recall from reading some of the documents, that it came about from the pharmacy people testing-- doing some sort of routine water testing and found the contamination that way. So what I'm saying, basically, is that, in England, that would have been started earlier and the testing would have been-- so, as soon as the hospital opened, effectively, all augmented care units would have been tested every six months and they possibly would have found the contamination earlier.

Q Okay, thank you. Just to complete----

THE CHAIR: My apologies, Mr Maciver. Just so that I'm following. So, if we looked at the HTM, the English-equivalent guidance to SHTM 04-01, you would find a specific requirement for testing every six months for Pseudomonas----

A Aeruginosa, yes.

THE CHAIR: Right, whereas we don't find that in the Scottish regulation?

A Not for routine testing. There is a requirement for testing if you have an outbreak.

THE CHAIR: Right.

A Yes. Well, you would have to identify the outbreak in the first case, which is exactly what happened three years later.

THE CHAIR: Right, thank you. Sorry, Mr----

Q Sorry, it was just to complete the thought and kind of bring it full circle for the last five minutes. We started out by discussing differences between Scottish and English water, and we finished by discussing differences between Scottish and English HTM for Pseudomonas. Are the two points linked at all? Do you know why the Scottish guidance is different from the English guidance? Is it anything to do with the type of water?

A Yes, definitely. Some of it is, yes. As I say, because you----

Q Specifically in relation to Pseudomonas, I mean.

A Right. No, I don't know why there's a difference there. In fact, I'm quite surprised there's a difference there, so I don't know why the Scottish HTM didn't take up the option of doing regular Pseudomonas testing.

So it was there-- I mean, in fact, I was involved in the group that wrote that document for the English HTM, and then the Scottish HTM would have looked at that document, but, for some reason – and I don't know why – they decided not to do routine testing.

I would say that, since it's been introduced in the English HTM, that it has been a bonus and it has been useful, and

it has helped to identify situations that wouldn't have been identified unless maybe patients started to appear with infections from Pseudomonas.

Now, the thing about that is that 50 per cent of us carry Pseudomonas aeruginosa on our bodies. It's a routine organism. If you take a swab from your body, 50 per cent of us will have it there, so it's a common organism and it can cause infections in hospitals anyway, not necessarily associated with water systems, so you could get Pseudomonas infections and wouldn't necessarily think about water as being the source of that infection. So it is a good thing to do, in my opinion, to do routine sampling to see whether or not the water system is presenting a risk to patients.

Q We'll never know the answer to this, but I think you said it's at least possible that, had the regular routine Pseudomonas testing regime been in place in Scotland, then matters might have come to-- the specific matter that we're interested in today might have come to the attention of the hospital sooner?

A I think it would, yes.

Q Thank you. Now, you also mentioned Dr Hood a moment ago. You mentioned that you had a separate meeting with him on 10 May.

A Yes, a separate meeting but

with Ian Powrie there as well. I met in Ian Powrie's office, I think it was, and Dr Hood was there. I met him back in-- I think around about 1995. I wouldn't be entirely specific about that, but he was interested because we had set up a trial.

There was an outbreak of Legionnaires' disease in the cardiothoracic centre at Broadgreen Hospital in Liverpool and, because of my expertise involved in that, the Department of Health had asked me to get involved in a trial of a new biocide, which was chlorine dioxide, which was used then to treat the water system in the cardiothoracic centre to try and stop this outbreak that had occurred in a number of patients in that unit.

It was a three-year trial, as I recall, and, in the end, it was effective and it stopped the outbreak, and it managed to eradicate most of the organisms. You can never completely eradicate organisms from water systems because they have the ability to go and hide in biofilms and then come out when you least expect it, you know, but we managed to control the outbreak and there were no further cases associated with the treatment of chlorine dioxide, which, as far as I recall, was a brand new biocide at that point, but Dr Hood had heard about this and he came up.

Now, either at the same time he was

using it in Glasgow Royal Infirmary to try and control an outbreak that was happening there at that particular time or he'd heard about it from me, so I don't know which came first, yes. He may have already started his trial with chlorine dioxide and then come up to see how we were doing, but he met me at the Royal Liverpool Hospital. We had a walk around the cardiothoracic centre at Broad Green Hospital, and he went away with some ideas and views and continued it.

I believe that the outbreak, which in Glasgow Royal Infirmary involved the death of two patients, I believe, from Legionnaires' disease-- I believe his outbreak was also controlled by the introduction of chlorine dioxide there then, so it was effective both in our hospital and in Glasgow Royal Infirmary at the time, yes.

Q Right. That was what I was wanting to ask. Your history with Dr Hood goes back some way, and specifically that was to do with chlorine dioxide?

A Yes, yes. Yes, I knew----

Q Yes.

A I didn't know him well, and I didn't know him before he contacted me to come up to see what we were doing at the Royal Liverpool, but I think there might have been the odd communication in between that. But after that, then I

think he went on to write his paper, which is a six-year study on the use of chlorine dioxide in managing an outbreak.

Q Is that what you discussed on the meeting of 10 May, chlorine dioxide?

A We started-- Yes, we sort of went down memory lane to a certain extent and talked about how chlorine dioxide had been effective for us both at that point.

Q Did you discuss with him the specific issue at the Queen Elizabeth?

A I don't recall doing that. I didn't particularly have a lot of information at that stage. We may have touched on it, but there were issues, obviously, which I was not aware of, further issues, which were-- which would have been relevant to a discussion on the water system there. But no, we kept it relatively superficial at that stage, I think.

Q Okay, thank you. Now, moving on, there were two reports requested of you at an early stage, as I understand it, one on something called Clorius2 and another one on the manual oblique automatic flushing of taps.

A Yes.

Q Is that correct? Were they asked of you during the same visit on 10 May? I don't mean were you asked to write them on that date, but were you asked----

A No, no. I don't think they were

mentioned on that day at that point. That came a little time afterwards, when Ian Powrie got in touch with me by email, I think it was, and first of all asked me to write a report on Clorius2. I think that had come about because the hospital were already starting to think about the use of a biocide, and I think they'd come to the decision themselves that it should be chlorine dioxide, at that point, that they should be using.

There was discussion about the use of silver and hydrogen peroxide, I think, maybe, or maybe even copper and silver ions, I think, but then it appears that they were heading down the route of going towards chlorine dioxide anyway.

Q When you say there were discussions about copper or silver peroxide, was that discussions with you, or is this internal discussions that you became aware of later by some other means?

A I became aware of that a bit later. It may be mentioned there briefly, you know? But one of my concerns about using copper and silver or silver and hydrogen peroxide is that one of the first organisms that they'd isolated was Cupriavidus, and Cupriavidus is an organism which sort of has the ability-- some of the species have the ability to resist treatment with heavy metals, such as copper. Well, as the name implies,

cupri, cupric, copper, avidus. Yes?

So it's suggested it has an ability to be able to withstand a certain amount of antibacterial control with heavy metals, particularly copper, yes. So I was a little bit concerned, if they were thinking about going down that particular route, as it might well not be effective against those sorts of organisms because there's an inbuilt sort of resistance, to a certain extent.

Q Now, just to be clear on the timeline of these matters, were those matters-- copper or silver, were those matters that had been discussed and discounted prior to you ever becoming involved, or were they matters in which your view was sought?

A Sorry, I don't-- I can't really recall that. The impression I got was that they were already sort of thinking about chlorine dioxide as the likely best option. One of the other things that would have influenced that as well is the high pH in the water there, and the high pH is not particularly good for copper and silver ions. It's not as effective in the presence of high pH.

Q Right.

A So chlorine dioxide, which has a better tolerance of high pH than chlorine, which is an entirely different chemical, that seemed to be the front runner at that particular stage, yes.

Q All right, thank you. Now, I'll perhaps come back to those reports in due course, but while we're discussing chlorine dioxide, can I, rather than-- You've given, in one of your reports, a very technical description of the Clorius2 system that you were asked about. It was never used, is that correct?

A I don't believe it was used, no.

Q So, I'll maybe just close that off by giving you my summary of what I understand the Clorius2 to involve and you can correct me or elaborate as necessary: the basic point is that chlorine dioxide treatment was required for the water, and Clorius2 was some kind of solution, I think, or delivery mechanism, whereby the chlorine dioxide could be introduced to the water.

Now, there are alternative delivery mechanisms. Clorius2 would be one of those, but that's the basic points, as I understand it, and your report discusses whether Clorius2 was an effective or appropriate delivery mechanism considering what was required in the context.

A Yes, yes. That's a fair assessment, I would say, yes, that the Clorius2 is chlorine dioxide, but it’s activated in a different way than conventional chlorine dioxide, which was eventually used in the hospital, yes.

Q Okay, thank you. Perhaps more straightforwardly, can you explain to me the significance of the automatic oblique manual tap flushing issue that you were asked to write the second report about?

A That was basically a sort of-- a decision which the hospital was trying to make with regards to how they were going to mix it up. Because one of the important things about dosing any water system with a biocide is that it has to get to all parts of the system, and it has to get to the outlets in particular, so the regular flushing of all outlets is very important.

A biocide will not work properly if it cannot get to the outlets, particularly as much of the contamination, very often, is associated with outlets, the contamination with Cupriavidus and Pseudomonas and various other organisms. These organisms are, in the main, obligate aerobes, which are organisms that like oxygen, so they would prefer to be at the outlet of a water system close to a higher oxygen affinity than deep within the system.

So, it is very important, if you're going to use a biocide to try and kill off organisms, that that biocide gets to the point where those organisms are and prefer to grow, which is generally at the outlets very often. You can get systemic, deeper contamination within the centre parts of the water system, but very often,

in my opinion, it's the outlets which get contaminated, so, a biocide has to be able to get to those outlets.

So the regular flushing of outlets can either be done manually, and so you just have people making sure they use every outlet in every part of a building on a regular basis. To that end, for instance, in the guidance, HTM 04-01 and in the Scottish guidance, it recommends that, in particular in augmented care facilities, that every tap is flushed every day.

Q Yes.

A And that is even in the absence of a biocide. That is to try and make sure that water is turned over and that you don't get the build-up of biofilm due to maybe stagnation of water occurring at outlets that may be underused.

Q Yes.

A So regular flushing of outlets is very important, and I was required to write a paper on whether the way forward, with regards to the flushing of outlets, should be done manually or whether or not it should be done automatically.

Q Okay. Right, at the risk of attempting a second summary, the basic issue here is that one of the sites where a build-up of pathogens might occur is at the end point of the water system, at the outlet, but the outlet occurs at the end of

a pipe and water doesn't necessarily flow up and down the pipe, and the only way to make water flow through the pipe is to flush to open the outlet, and it's that which draws chlorine dioxide throughout the whole system?

A Yes, with the exception of part of the hot water system, because the hot water system, unlike the cold water system in big buildings particularly, recirculates, so it's constantly moving – or should be constantly moving – because there are pumps driving that water through the system, basically.

Q Does it follow from that, then, that the taps in the cold water systems are more important or a more important issue than the taps used in the hot water system?

A In some ways, yes, because, if you think about it, the cold water system, effectively, all of it is a giant dead leg. There is no movement of that water unless somebody opens a tap, so-- but if you've got a hot water system that hot water recirculates from the big hot water heaters, called calorifiers very often, and that will recirculate around the whole building and then come back to the calorifier, where it's heated to normally about 60 degrees centigrade, which would kill off most organisms.

So there's an intrinsic sort of control mechanism there, and then that would

send that water back off again around the system. The only parts that wouldn't move necessarily would be the stab-offs to the outlets themselves, so the recirculating system should move and then the pipework going to the individual outlets will stay static. That's hopefully a small section, unless the outlet is opened and then the hot water would then move through that as well, but most of a hot water circulation system moves.

But this is where big is not necessarily beautiful. When you've got very big buildings, you have secondary and tertiary loops of water systems looping from one after the other. Sometimes it's very difficult to be able to get a balance in that where you've got the right differential pressures and the flow of the water around all parts of the furthest loops of that water system.

Q Right.

A It's very difficult to manage.

Q So, one of the first things we spoke about was your initial impressions of the size of the site----

A Yes.

Q -- and the size of the water system. I think I started asking about complexity, but perhaps I asked you about something else. If I did, then, is that what-- Well, if I asked you about if the complexity of the water system brought its own problems, is that what you would have had in mind, the presence of secondary/tertiary loops because the site was so big?

A Yes, it's partly that, yes. In fact, in a reasonable-sized, a normal-sized hospital-- The Queen Elizabeth was very big, but in normal-sized hospitals, you would find that they would all have some issues in terms of recirculation of hot water around secondary and tertiary loops, in my experience. But again, I tend to be drawn towards problems-- hospitals that have problems----

Q Yes.

A -- so I have a disproportionate view, to a certain extent, yes.

Q No, I appreciate that. I see we're on page 9 of the statements. I wonder if we can scroll down to the bottom half of that page. There was one part-- In the paragraph beginning, "After one gap of three months without contact..." I wonder if you can just help me with the timeline here. That reference to the gap of three months, when was that? Initially, as I read this, the initial contact had been in April and May, but I'm aware that you filed your reports in June or July. So, presumably the gap of three months was not during that period. When was that gap of three months?

A I think I emailed Ian Powrie on 7 December 2018 about the fact that they

hadn't been in touch. I was a little bit concerned that they were maybe not holding meetings as often as they should do, given the issue, so I asked him did they need my services anymore because they'd gone quiet.

There was a gap, I think, of, in total, about eight months in total, yes, which-- I subsequently found out there had been meetings. I mean, that eight months was not without activity, clearly, at the hospital, but I wasn't aware of that necessarily, yes.

Q You mention at the bottom of that paragraph exactly what you've just mentioned: you became aware that other meetings were taking place, “which is reassuring,” or, “It appears these were frequent, which is reassuring.”

A Yes.

Q At that time, you were-- you had a general concern that your involvement was irregular.

A Yes.

Q When you say that learning about these other meetings was reassuring, is it simply the fact that other meetings were taking place that reassured you, or did you have more information about, for example, what was being discussed and dealt with in those meetings?

A I didn't have information about what was being discussed, no. I was not-- as I recall, I was not given documents from those meetings.

Q So simply the fact that things were being done, albeit that you didn't know what those were?

A Yes, I didn't know what was being done, but certainly when I met the incident management team initially at the first meeting on 10 May 2018, I was struck by how committed they were, and obviously I knew Dr Hood and how committed he was and the work he'd done on chlorine dioxide and the papers he'd written on that. But I also met the rest, or some of the other members of the team there, and they were clearly very committed.

So I was pleased that they seemed to be very competent and going about it in the right way, so I took the view that they didn't necessarily need me at that point, but they did get back in touch with me. I did-- I think I had a total of eight or nine meetings, I think it was, in the two and a bit years that I was associated with them.

Q Now, you may or may not be able to answer this, but throughout that period – and I suppose I'm talking from your first dealings in May 2018 up-- for the next 2½ years – was your impression of a water system that was under control?

A Well, it's a difficult question to answer, that, because in terms of

microbiology, most of those organisms that were being discussed and being isolated from the water system would not have caused a problem to most of the people in the hospital, or to you and I or anybody else, effectively, but immunocompromised patients were what we were concerned about and so that obviously did represent a threat for them.

So, it was a different tier, yes. So there was a concern about the water quality with regards to that. They were certainly making a lot of effort towards addressing that issue. I mean, the meetings, the fact that they asked me to write two papers on the particular problems there meant that they were very serious about resolving that issue, yes.

Q Okay, no, thank you. I appreciate that. More specifically, perhaps, your particular concern was the time lapse between the meetings that you were actually at.

A Yes.

Q Given the profile of the problems that the hospital was dealing with and that you'd learned about from May onwards, would you have expected to be involved more frequently in those meetings?

A I would only say that normally when I'm invited in to advise a hospital, I am involved more often than the hospital, the QEUH, had me involved. So, it's-- I

suppose I would have expected to be involved more, but they had a lot of expertise there. As I said, Dr Hood had a lot of expertise and others, Dr Inkster, and so there was a lot of expertise there. I came to the conclusion that they don't necessarily always need me for all of the nitty-gritty detail and they didn't involve me in the nitty-gritty detail.

There was just a certain level of information I was given and was asked to get involved with. I wasn't asked to go around the plant rooms and see that the engineers were doing their particular tasks and so on, and so very often in other hospitals I'm required to do that and carry out audits, for example, but in this case they had a bigger team, it was a bigger organization.

They had a lot of people with a lot of expertise involved there, and it looked like they just needed me for certain requirements, certain things, which was fine, as far as I was concerned. I was not given a particular job description or, you know, detail about what I was required to do, other than the specific request to write those two particular papers.

Q Well, I suppose my question, then, is that you've offered a number of reasons why you might not have been required to be involved quite as much as you would have expected. Do you know that those reasons are actually why you

weren't involved, or is this, to an extent, reverse-engineering an answer from a speculative way?

A Yes, it's a bit more speculative. I don't know particularly why I was not needed, no.

Q Moving on to the next page of the statement, you describe your role, and I think you might have just said pretty much the same thing a moment ago: “As I understood it--” Yes, it's at the bottom of that page:

> “As I understood it, my role was to provide advice on the prospective measures for controlling microbial contamination of the water system to help reduce risk of nosocomial waterborne infection rather than focusing on the possible causes of that contamination, though some knowledge of the latter was appropriate.”

Firstly, what does "nosocomial" mean?

A Hospital-acquired.

Q Right, and secondly, was your understanding, as you describe it there, one that you reached for yourself, or was that an instruction specifically given to you by the Queen Elizabeth Hospital?

A No, there was no specific instruction given to me about how my involvement with them would go forward, apart, as I say, from the two documents--

the two papers I was asked to read-- to produce. It was my-- that was my view, actually.

Q Looking back, would you have considered there to be other matters that would have been worthy of your consideration but you weren't asked about?

A It depends on how-- yes, yes. I mean, I've got a lot of expertise in water systems and where things can go wrong, and I've been doing it for many years and so, had they asked me to be involved in that, I suppose I would have done, but that would have required me going there more often and being involved a lot more.

And, at each meeting, at each of these eight or nine meetings than I went to, I used to ask at the end of each meeting or by email the next couple of days, would I be required for the next one. So it was never known whether I would be required for the next one.

Q Were you actually proactive in saying, "Issue X might arise. It would be useful for me to be involved in that. Shall I attend the next one?" Or was it more reactive than that, simply asking----

A I think it's a bit of both, to be honest, yes. A bit of both. It was generally more reactive, but I would suggest certain things and it might well be, though, that they went along the lines and looked at that thing that I'd

mentioned but they'd done it themselves, but I was never particularly informed about what had gone on. I didn't necessarily receive the minutes of the meetings that I didn't attend, wasn't asked to attend.

Q Okay, thank you. We've focused, I think, largely on the initial period of contact with you, the first meetings in May, perhaps up to your reports in June and July. Did you feel that you gained an understanding of what the underlying causes of the issues actually were?

A Yes. Well, the underlying causes, as far as I'm concerned, obviously was an issue of the size of the system – it was so big; it's so much more easily contaminated when you've got a big system like that – but also, in particular, as I sort of mentioned earlier, that because of that size and because of the-- during construction that has to be filled with water at some point, you don't know what's gone on after that point, whether it's been regularly flushed or whatever, whether there was a biocide used at that particular time.

The guidance does refer to the fact that a biocide can be used immediately when water enters the system. So your guidance, SHTM, does refer to that, and so all of these issues would have been relevant to whether or not the system

became contaminated, yes.

So, it was a very complex problem which involved a lot of issues, and some of them were sort of outside of the control of the people who were then occupying the building, to a certain extent, because they may have inherited some of the problems.

Q Right, thank you. At this point, I'd like to come back maybe a little bit to ask you again about your initial impressions of the site, specifically an issue you raised yourself, but----

THE CHAIR: First, Mr Maciver, just to understand. (To the witness) You were asked if you'd got an understanding of the underlying causes of the issues. You identify the size of the system. Now, you then, as it were, elaborated that by saying, because the water system must be filled at one stage, you don't know whether it was flushed and you don't know whether any disinfection or biocidal treatment was used initially.

Now, I'm not putting this terribly well. When you answer the question, you understood the underlying causes. I think I'm rather taking from your answer, well, you say this is a very big system, and whether or not it was flushed, or whether or not it was subject to initial biocidal treatment, you don't know. Is that right?

A That's right, yes. I didn't have that information.

THE CHAIR: That's right? Do you want to take that any further, Mr Maciver? Are you content just to leave it there? What I'm getting from that is that the size of the system merited these measures. Whether the measures were taken, you're not sure.

A That's right. I don't know if those measures were taken. They definitely were needed----

THE CHAIR: They definitely were needed?

A -- and, in fact, they were advised by the Scottish HTM, so regular flushing of outlets is advised. During construction time, once water gets into the system, it's advised by the Scottish HTM. I think it's twice a week or every three days or something, it says, and it also advises that biocides may be used in that time.

It's fair to say that it's just guidance and it's up to you whether you take that guidance or not. But certainly, in my experience, with all the information I have now from hospitals with problems and certainly in new builds, it is, I would say-- shouldn't be guidance. It should be instruction to, first of all, make sure all of these outlets are flushed on a regular basis, and that water systems are treated with a biocide from day one.

Whether or not you stop that at the point of handover-- because you won't necessarily want the patients exposed to that particular biocide, or you may not need it after that point because there would be normal use of the outlets and so hopefully regular use of the outlets and that would reduce the opportunity for bacteria to build up in the system. But I would certainly say-- given my experience, I would say a biocide should always be used in the construction of a building once water enters that water system.

THE CHAIR: Thank you.

Q Now, just coming back to your initial impressions of the site, one point you touched on was the proximity to sewage works, and at two pages further on in the statement at the foot of page 12 of the bundle, you mention being shocked by this.

A Mm-hmm.

Q You say:

> "I was concerned regarding possible implications for the hospital and its patients arising from potential increased transmission of microorganisms from the sewage treatment facility. Airborne transmission of microorganisms from sewage treatment works is well documented."

I wonder, can you elaborate on that? What are the mechanisms for such risk, as you understand them?

A Well, I mean, sewage treatment, obviously, you're dealing with faecal material and there's a lot of pathogenic organisms in faecal material and there's a lot of agitation and aeration in the process to break down the sewage before it's discharged to the environment, and in that process itself, it generates aerosols. Aerosols would contain these microorganisms, some of them pathogenic, and they can be transmitted. They can be picked up.

Aerosols are very small microns and they can move fair distances, so you can get airborne transmission of these microorganisms within a certain distance of sewage treatment works and, as I say, this has been well documented. There's lots of papers on this and so to actually have a hospital that contained highly immunocompromised patients within a couple of hundred metres – maybe 300, 400 metres maybe-- I never actually paced it out, but it looked very close to me. To have a sewage treatment work so close to a hospital that had such immunocompromised patients, to me, seemed an unacceptable risk, really, so I was surprised by that.

Q Right. Just to expand upon that a little bit, you may or may not be aware that the hospital site was the site of a previous hospital and, indeed, that the present-day hospital includes much of

the retained estate from that previous hospital. Were you aware of that?

A I saw the old buildings. In fact, where I had the first meeting with Ian Powrie was in a very old building, which probably predated the water treatment works, yes.

Q Does that fact change your view at all about the----

A It would suggest that the sewage treatment work was built after-- after the original hospital at least, but I don't know which came first in terms of the new hospital-- (knocks microphone). Sorry, I keep doing that-- which came first, the new hospital or the sewage treatment works. I didn't know how old the sewage treatment work was, so I didn't know which came first.

Q I wonder if we can go forward in the statements to what I think will be page 41 of the bundle, because you return to this matter again at the end of the statement.

THE CHAIR: (Inaudible) still on bundle 15?

Q (Inaudible). No, still-- this is the statement bundle.

THE CHAIR: Statement?

Q Yes, sorry.

THE CHAIR: Sorry.

A Can I just see the bottom of that page, please? Page 41, is that-- 39, thanks. That helps me with my

documents, thank you.

Q Sorry, I'll bear that in mind where-- you're the first statement in the bundle, but we have a title page that's throwing the numbering out by two, so----

A Yes. Yes, thanks.

Q Right, so you've returned again here-- If we go back up a couple of lines, you return again here to your shock at having found the hospital and the sewage treatment in close proximity. Second paragraph of that section:

> "I'm not aware of the impact of proximity of QH to the sewage treatment works has been fully investigated."

Does it follow from that, moving forward to the present day, that, in your view, that's still a risk factor today?

A Yes. If the sewage treatment works is still there, then I would say it's still a risk factor and I feel it would be appropriate, given that there's been so much testing done of the water system in the hospital, that it would also be appropriate to look at airborne transmission from the sewage treatment works around the sewage treatment work and certainly in the vicinity of the hospital. So you could do air sampling and water runoff sampling and so on and see if that, in some way, was getting into the environment of the hospital.

Q And, just to close the point, are you aware of such investigations having been done at all?

A No. That's not to say it hasn't, but that I'm not aware of it.

Q I understand. Now, returning to a slightly different point regarding your initial impressions of size, complexity, if we move back in the statement to what will be page 28----

A In my document?

Q -- of the statement 30 of the bundle.

A Yes.

Q In the middle of that page, you are making reference to the presence of single bedrooms with en-suite facilities.

A Yes.

Q Is that an aspect-- well, it clearly is, you say that it increases the complexity of the water system. I wonder if you can just explain your thoughts on that.

A Yes. If you have single bedrooms, they all require en-suite facilities. You know, you need hand washing, you need toilets, you need showers and, normally, in a hospital that doesn't have individual bedrooms like that, that would be more communal and so there would be less of them. So as soon you go to single bedrooms, there's a proliferation of extra pipework, extra outlets, extra taps, extra showers, extra toilets, and so it makes the whole system

that much more complex, really.

Q Okay.

A And while it's good from a point of view of infection control, in terms of having all these patients separate from each other in that way, it actually creates another problem with regards to infection control, in my opinion, in that it makes the water system so much more complex and open to be contaminated.

Q And to summarise that issue, it creates-- would it be fair if I described that as creating more scope for dead legs?

A Absolutely, yes, more scope for dead legs and-- particularly if any of these outlets are underused, and some patients might not be in a position to be able to use some of these outlets; they may be bedbound and not using, say, the wash-hand basin or the shower or even the toilet in some cases. So it very much seems to depend on what the patient is doing, and not all patients can activate the outlets in their rooms.

In that case, it would normally require someone to be aware of the fact that the patient was not doing that and do it for them – flush the outlets on a regular basis – but people in wards in hospitals obviously have an awful lot to do, and to go around flushing outlets on a regular basis, I suppose, is another task that would be asked of them.

Q Did this come up at all in your work with the hospital, or is this just a matter that struck you as unusual?

A No, it-- well, it struck me, but also it came up in terms of some of the discussions and the individual bedrooms made it so much more difficult, and that's why a flushing program had to be produced, really, and how outlets were going to be flushed going forward once they'd introduced the biocide-dosing regime.

Q Thank you. Moving back to page 13 of the bundle, page 11 of your statement, you made a reference there. It's half a dozen lines from the bottom of what we have on screen, so your concern that biofilm may have been allowed to develop during the construction of the building. I wonder, can you explain how you came to that conclusion?

A Because----

Q I wanted-- sorry, am I going too far in describing that as a conclusion? Was it a suspicion at that stage? You say “concern;” I don't want to put words in your mouth.

A Yes, it wasn't really a conclusion; it was a suspicion because I'd been furnished at the very outset when Ian Powrie sent me a couple of documents-- One of the documents he sent me was Dr Suzanne Lee's report, who had been to the hospital, I think, in--

before me, anyway, in April or somewhere around about then, and she'd written a report on the water system and she had said that the system had been filled during construction and remained so for over 12 months prior to it receiving patients.

Now, that's an unusually long time to have a water system filled before it goes into operational use, so I was quite surprised. I mean, as soon as you put water into a system, it gives it the opportunity for biofilm to develop and you should really only fill a water system as late as you can prior to just it being used-- the building being used.

I accept that the people who constructed it have to put water in in some cases to test whether it's leaking and whether it's functioning properly, so there is a period of time required for them to be able to do that and so there'll have to be-- water go in there for them to allow them to do that, but if you do it too early – and I would consider a year prior to patients moving in too early – then that leaves it open, the opportunity for contamination to occur, and not just for contamination to occur but--

Because we're not just talking about microorganisms entering the water system and floating around; we're talking about organisms getting into the water system and establishing biofilm, and biofilm is particularly-- once it gets established, particularly difficult to remove.

Q Well, when you say in the middle of that paragraph, "Once biofilm becomes established it can prove very difficult to control," by control, do you mean eradication?

A No, control. Control is management of it. Reduce the risk. As I said earlier, you cannot, in my opinion, eradicate organisms from water systems. There will always be an element of microbial contamination. Fortunately, in most cases, the contamination is associated with relatively innocuous organisms, which would not cause a problem in many situations because no water system is sterile.

You're always going to have microorganisms there. It's just that, in hospitals that treat particularly immunocompromised patients, they are particularly prone to infection with almost any organism, really, and the less harmful organisms in the water system – less harmful to you and I – may well cause a problem to them.

Q You speak about the biofilm's particular capacities for resistance or persistence. Does it follow that that emphasises the importance of trying to prevent it from forming in the first place?

A Yes, yes. I think prevention is

always better than cure because you can, in this case, never establish a cure. Prevention really should be trying to make sure that you don't give the opportunity for those organisms to develop in a water system and, as I say, one of the ways in which you would do that is put water in as late as possible to test the system.

In some situations, you can actually test the water system for leaks and so on by using inert gas such as nitrogen and look for leaks coming from that, and then you haven't put water into the system until maybe a week before patients go in there.

But there is always a requirement to do a final disinfection before you hand over to the people who are going to use that particular building, so a final disinfection would involve a higher level of a particular biocide. It's usually chlorine that is used at something like 50 parts per million, which is quite a high concentration for a specific period of time. So that is the-- that should be the sort of final process.

One of my concerns, though, about this, and I think it's relevant, is that the-- this is relied upon far too much, that the use of disinfection as the final stage after the construction is what a lot of people in the construction sort of industry think is adequate to get rid of any of the sort of

previous ills, the problems that may have occurred, and the disinfection will resolve all the problems. It won't.

Q Okay, so you're saying that the very fact that dosing, chemical dosing, exists as a treatment might encourage greater risks or less care before knowing that it might----

A Yes.

Q -- that the treatment may be introduced later?

A Yes. I think a lot of people rest on the fact that that final disinfection will make it all right, yes? It will get rid of any contamination that may have crept in at some point, but one of the things that I've commented on in my statement is that this biofilm that can accumulate, given a long enough period of time, is particularly-- helps organisms to become resistant, to a certain extent. They don't become resistant within themselves, but it protects organisms from the biocides that may be put into that water.

Q Are you able to explain, in simple terms, how that happens?

A Yes, so if you give an organism or organisms that are waterborne an opportunity, sufficient opportunity, they can attach to the surface-- internal surfaces of pipework or cold water storage tanks or calorifiers or whatever else, vessels, and they can then start to produce a sort of

polysaccharide, a glue-type matrix, which allows them to attach to that surface and stay there.

Q How does the resistance occur?

A Well, the resistance comes because the polysaccharide matrix, which continues to flow out of them, really, sort of covers them, and it's a mucoid sort of coat, if you like, which makes it that much more difficult for biocides to penetrate to the organism to kill it.

So there have been a few papers which say that you need something like 100- to 1000-fold the level of biocide in a water system that's got biofilm in it to kill off the organisms within the biofilm, as opposed to if organisms were just free floating, planktonic in the water system.

Q Right, so the short summary of that would be that once they are there, it's harder to get rid of them than it is to prevent them from attaching at all?

A Indeed, and they are tenacious; they will stay there. In fact, I would say it's almost impossible to get rid of them once they've become established.

Q If we skip on a page in this statement, you make a reference right in the middle of the screen just now to SHTM 04-01, part B, section 7.6, stating that continuous dosing with----

A Sorry, is this page 12 of the document?

Q It's page 12, sorry. Yes, 12 of your paper copy. (Inaudible).

A And which second paragraph are we in?

Q It's the reference to SHTM (inaudible)----

A Yes, got it, yes.

Q -- page, states that:

> "Continuous dosing with appropriate biocides that have proven efficacy should be considered during construction to prevent the accumulation of biofilm."

And is that the process, effectively, that you've just been talking about?

A Yes.

Q But it itself brings a kind of moral hazard with it in that it might encourage more risk-taking than is----

A No, no, we're talking about two different things. That is the continuous dosing of a biocide there, and that is the guidance that's in the SHTM 04-01, and that says that once you put water in a system you can use a biocide to help prevent the build-up of biofilm in that situation.

What I was talking about earlier was the terminal disinfection, effectively, which is after the construction works and then before they hand over, there's a one-off – hopefully – disinfection using a high level of chlorine. Normally chlorine;

you can use other chemicals there as well. But this reference here is continuous dosing with biocides and this is at a lower level, lower concentration, where you have continuous dosing to try to help prevent the build-up of biofilm in the first place.

Q Is it implicit, then, within that reference, that-- or would you go so far as to say that the implication is that hospital water systems should all have dosing?

A Yes, that's what I said earlier. You really-- my view is that this is guidance, SHTM is only guidance, but it is obviously something which has to be taken account of. In my view and in my experience, given the problems that there are in new builds, I would say it should always be used. There should always be biocide. As soon as water hits a pipe, basically, there should be a biocide in it, and if they want to stop that dosing at the point of handover to the users of the hospital, that's fine, but up until that point, to reduce risks, my view-- and particularly in hospitals as big as the Queen Elizabeth University Hospital there, it would certainly be required.

THE CHAIR: Dr Makin, can I-- You drew the distinction between continuous dosing during construction, which is dealt with on what's either page 12 or page 14, which you've just been asked questions

on. Now, you contrasted that with what you were previously being asked about, and can I just check with you that I've got my note correctly? I've noted you as saying-- is there's always a requirement for final disinfection----

A Yes.

THE CHAIR: -- and I think you'd explained previously that filling a system with water should be delayed as long as possible.

A Yes.

THE CHAIR: Testing a system with an inert gas such as nitrogen should at least be considered. My question is, when you say, as I've noted you, "There's always a requirement for a final disinfection," is that a requirement that we find in either the HTM or the SHTM, or is it a matter of good practice or your opinion?

A I think it's in both those documents and it's also in British standards as well----

THE CHAIR: Right, okay.

A -- and how to do it is detailed in the British standards as well.

THE CHAIR: Right, thank you.

Q One last question arising from the page that's currently on screen. The paragraph at the foot is a mention of-- well, it's moved up now, but SL's report also noted there was no data available on water temperatures as the hospital's

computerised building management system had been faulty. Now, I won't get you to elaborate on this, but I think it's well understood that temperature is an important feature of the control of a water system. With that in mind, what are your thoughts on Dr Lee's observation that you record in that paragraph?

A Yes. I mean, Dr Lee had obviously been provided with information that I wasn't aware of anyway at that stage and she had discovered that the building management system had been faulty and so it was not recording the temperatures presumably of the-- in particular, the hot water system.

That's quite important because temperature is a very good control mechanism for microorganisms and water systems, and the guidance says that you have got to achieve 60 degrees centigrade coming out of a hot water heater or calorifier and coming back at no less than 50 degrees centigrade back to the calorifier, and this guidance refers to that 55 degrees centigrade is required at outlets.

Now, most outlets in hospitals have thermostatic mixing valves in them and that is to prevent scalding of patients, in particular, so there's a blend and a sort of automatic blend of the hot and cold water system. So at the outlet itself, it would only have water coming out at about 41

degrees centigrade, but up to the thermostatic mixing valve – and this is the business I was talking about earlier, the recirculation of the tertiary loops – that water should be 55 degrees centigrade at least, getting up to the thermostatic mixing valve and recirculate back.

So, it would appear from Dr Lee's report that there was no data available on the temperatures of that water at that particular time. That's not to say that the temperatures were not necessarily being achieved, but, if there's no evidence, we can't prove that it was achieving a satisfactory temperature that would generally control the microorganisms that may have been in the hot water system.

Q That was what I was going to ask: what conclusions does that lead you towards? Not as regards to what the temperatures actually were, but what conclusions does it lead you as towards-- as regards what overall level of control was being maintained of the water system?

A Well, I suppose, at this stage, we may have been talking about the sort of temperatures before the handover and so, during the building and the testing of the hot water system in particular, that building management system--

Unless somebody was going around and physically testing the water temperatures themselves, which very

often happens as well when the building is occupied, the building management system would appear as to being the only resource with regards to what were the temperatures of the hot water system at the various stages, i.e. at the calorifiers and at the various circuits. And if this information was not available, then I can't really comment on why it wasn't available, but we couldn't have had confidence in the control of that particular system at that stage.

Q Thank you. Now, that's a convenient point, my Lord, to pause for the morning break.

THE CHAIR: (After a pause). Yes. Dr Makin, as I said, we will take a break for coffee. We're now at half past eleven. If you could be back for ten to twelve? Thank you.

(Short break)

THE CHAIR: Mr Maciver. Thank you.

Q Now, the next part of my questions will be about some reports that were compiled either prior to or during your involvement, not by yourself. For reasons of time, I'm not going to take you to the bulk of those reports, though you may have seen them as they're on the document list.

The first one I'd like to refer to is

referred to at page 15 of your statement, page 17 of the electronic bundle, which is the 2015 DMA Canyon Risk Assessment report, referred to in the middle of-- It's page 15, sorry, of the electronic bundle, 13 of the statement. Two pages back, please, on the screen. Thank you. Question 7 was asking----

THE CHAIR: Sorry, my fault, Mr Maciver. The bundle number for the report?

Q It's page 15 of the bundle, the electronic bundle.

THE CHAIR: Well, that's the witness statement, but the report?

Q Oh, the report is at-- It's in bundle 6, page 122.

THE CHAIR: Thank you.

Q Now, I'm not actually going to take you to that report – you've seen it; it's very lengthy – but what I'm interested in is that you mention in your answer to question 7 that you don't recall having seen that report. Then, at question 8, slightly further down, that appears to imply that you did see the reports but not at the time of your first meeting at QEUH. Are you able to be any clearer today as to when and perhaps by whom?

A I've given it a lot of thought, actually. I've tried to think about when I first saw it, and I can't recall when I first saw it and I can't be absolutely sure that I didn't see it for the first time as part of the

bundles that were provided to me for this Inquiry. So I'm not absolutely certain when I did first see that report. All I can say is that it wasn't shown to me at the very beginning----

Q Yes.

A -- when I first met with and talked with Ian Powrie.

Q Okay. Well, that's fair. My question then, in that case, is that once you did see it, were you surprised that you had not been shown it at the very outset by Ian Powrie?

A It was of some relevance, yes, clearly, because it set out a number of problems in the water system which were identified during the risk assessment. So it would have been useful for me to have known some of that information that was discovered during the risk assessment, but it was not absolutely essential for me to know that because, as far as I understood it, I was required mainly to discuss the issues going forward in terms of controlling the organisms in the water system.

And, obviously, this was a retrospective view, but had an impact on the water. It all depended on what they had done since they'd had that risk assessment report in 2015, presumably, yes.

Q Well, that was my follow-up question, which was, were you surprised

when you saw the report to learn that, in fact, action wasn't taken to implement the recommendations in the report?

A Yes, there was a number of things which sort of went against guidance necessarily or didn't necessarily follow the guidance. So there were problems that were clearly identified in the risk assessment that would have supported the growth of microorganisms in that water system, and that was picked up clearly at that stage in 2015, which I think was just prior to the handover of the hospital.

So, the problems were there already, so they discovered that, so it was a surprise to me, really. But to be absolutely honest in terms of, am I surprised when I see these things? I'm not, really, because I see them so many times in hospitals that there are problems, there are issues. There are certain standards, there is certain guidance, but they don't necessarily have to be applied. That's the nature of guidance, I suppose. Where they're not applied, you invariably find there's problems, and this identified some of those problems.

Q The next document you mention is-- it's question 9 there, the 2017 DMA report, and I think you're a bit clearer that you hadn't seen this----

A Yes.

Q -- prior to the Inquiry. Now that you have seen it, and seen the 2015 and 2017 reports together, what's-- In general terms, can you comment on what impression that gives you of the extent to which the system was under control at those times?

A Yes, they were-- In those intervening two years, from the 2015 to the 2017 risk assessments, you could see that some of the problems were still there, identified in the 2017 risk assessment that were mentioned in 2015, so they hadn't necessarily been addressed from the 2015 risk assessment.

So, there were issues there, and there were significant issues as well. They were particularly relevant, and I was concerned about the number of issues that were identified in the 2017 risk assessment.

Q Were you concerned both about number and about specific issues----

A Yes.

Q -- that you saw there?

A Yes, and I listed a lot of them in my report on page 14----

Q Yes.

A -- of my document there. You can see them. I particularly highlighted a number of them.

Q Is there any one or two that

strikes you as being of particular concern, from your perspective?

A Yes. I mean, in fact, I go into that on page 15, as I see it. The particularly notable risks are, in the first instance, at that stage, 2017-- the risk assessment had identified that the person who was responsible for the water system, basically the RP or AP, had received no training on the control of Legionella and other microorganisms.

Now, was that a failing of the hospital in terms of not ensuring that person had that training? It should have come from them, presumably, to make sure that that was going to happen. That was a massive water system that needed controlling and the person needed the expertise to be able to deal with that, and to not have the training, that stuck out for me right away as an issue that needed to be addressed quite quickly.

The fact that there was no service history for the showers and most of the thermostatic mixing valves, for instance, which require servicing on a pretty regular basis, according to the guidance and the standards that are out there, there's no evidence of that. And other problems in evidence of significant heat gain in the cold water system getting as high as, I think, 30 or over 30 degrees centigrade.

Now, organisms start to multiply as

soon as the water temperature starts to increase, you know, and if you go above 20 degrees centigrade, then they really can start to grow quite rapidly and biofilm accumulates quite rapidly. It's not a hard and fast line, this 20 degrees, like at 19 they don't and at 20/21 they do, but it's a sort of gradient. As soon as you start to get warm cold-water temperatures, you can see problems.

There was an indication in the risk assessment that the temperature was getting above 20 on a pretty regular basis or in different parts of the system, and it was achieving, I think, 30 or slightly over 30 degrees centigrade in some parts of the system, which is a big alarm bell, really, if you start thinking about, you know, but bio-- You know, you really need, like I said before, biocides at that stage in the cold water system to help to control that.

If you find that you can't control the water temperature by natural causes-- Because very often in cold water systems, it's about heat gain. The incoming mains cold water supply, very often, is cold enough and is good enough to stay below 20 degrees centigrade.

They have a problem down in London and southern parts of the country where the incoming mains water supply is very often above 20 degrees centigrade, particularly in the warmer summer

months, but up here, you wouldn't normally expect to see that. In most cases, the mains water supply is below 20. So any heat gain then associated with water, cold water, getting to 30 must be associated with the building itself and that there's heat gain caused by something that shouldn't be doing that.

Q Okay, and then continuing with those points, those seven bullets, the other side of the coin, I suppose, is the inadequate water temperature from the calorifiers.

A Yes.

Q And that's, as I understand it-- correct me if I'm wrong, but that would be the opposite problem, whereby at high temperatures you don't get microbial proliferation, but if that drops below 50/55, then you start to get onto the other end of the curve that you've just traced out.

A That's right. It's particularly important that the calorifier gets above 60 degrees centigrade because you get an element of pasteurisation of the organisms that are then going to be sent out into the water system.

If you can maintain a temperature of 55 degrees centigrade, as I say, in the recirculating parts of the hot water system, that will help to keep most organisms at bay. It won't necessarily kill them off at that temperature, but it will

reduce their opportunity to multiply at 55 degrees centigrade.

Q Okay, and the last three bullets relates to debris, to dead legs, as we've discussed, and an issue around flushing of expansion vessels.

A Yes.

Q So those seven are the points that we should understand to be the ones that are of particular concern as not having been addressed?

A Yes. They struck me right away as being of particular concern, but there were lots of things mentioned in that risk assessment, all of which needed to be addressed.

Q Thank you.

A And, to be fair-- and I think you have to sort of draw a comparison on this, that risk assessments are required really in all healthcare premises and they're done on a pretty regular basis. It used to be that the guidance at one stage said, "You do a risk assessment with regards to water quality every two years." Now, it's changed a little bit and it says, "Where there's any significant change to your water system, you would do a fresh risk assessment or a review of the risk assessment."

When you do risk assessments on healthcare premises, you always come up with issues. It would be unfair to say that you don't find things. I have never

found a risk assessment which has come away saying, "I didn't find any issues, perfect," you know?

All of the risk assessments I've seen, I would say, have always identified issues in even the best-run hospitals, so they all have to pick up on issues. So, it's not unusual to see a list of things that have been addressed in risk assessments, but these are particularly important ones, yes, high-ranking ones, yes.

Q Thank you. Moving on to the next page, question 10, there's a long answer from you relating to a number of Intertek reports. The one that I'm interested in is the first one that's mentioned, the one of 11 July 2018. We'll find that at bundle 27, volume 1 at page 515.

(After a pause) Now, the particular features that I'm interested in-- I think there's three pages I'll take you to. The first one would be page 517, and that's a table of results. As I understand it, this was an analysis of flow straighteners in 17 locations within the hospital, and those locations are set out in the second column, is that right?

A Yes, yes.

Q Now, you mention-- and I'll just read out the part of your answer. It's on page 17 of your statement, page 19 of the electronic bundle. You're describing

this table:

> “Of the 17 flow straighteners tested, 9 showed heavy visual fouling and 12 produced a strong instant reaction for biofilm. These results indicate that the flow straighteners were heavily contaminated with bacteria and were colonised with biofilm to various extents.”

Now, if we can flip back to the table, those references to 9 and to 12, are those references to the last column and to the, I suppose, the third-last column?

A Yes. Yes, they are, yes.

Q I wonder, can you explain what concerns that prompted for you?

A This indicated to me that there was a sort of intrinsic ability within these flow straighteners, which are devices that are introduced to the end of tap outlets----

Q Yes, sorry, I should have asked that first of all. Explain to us.

A It's-- okay, well, I'm not a plumber, so I don't exactly know, but I do come across a lot of flow straighteners because they cause a lot of problems in hospitals, so much so that the guidance now advises against installing them, against using them, and the flow straighteners in this particular case have been taken from various parts of the hospital and analysed.

And you can see from the column that says, "… the estimate total count per item," so that's per flow straightener, is that there's some very large numbers there and they are the counts. In some cases-- I think it's 20 million in most cases, so you're looking at very high counts, so 2 times 10 to the 7, yes, which is very high counts of organisms.

So, they've recovered by washing-- taking these flow straighteners out, washing them in a diluent and then culturing that diluent onto agar plates and doing various dilutions to try and get an idea of the number of organisms there, which is always quite difficult to do because you don't know at the outset what there is there.

Well, you can see that, in every case, they've recovered a very large number of microorganisms from every one of those flow straighteners, so that is an indication, plus when you look at the end column there, biofilm, that is a sort of relatively crude assessment of the amount of biofilm which is present in the flow straighteners, and that is measured sort of in a semi-quantitative way by adding hydrogen peroxide, which is the reagent that was used here, to the biofilm.

Now, in biofilm, because there's so many organisms, they produce an enzyme called catalase. Catalase breaks down hydrogen peroxide and it is

effervescent when it does that, so you see visible bubbles as soon as the two come together and that's what they've done in this relatively crude test. But it is quite useful to show, one, that you've got biofilm there and it comprises a lot of different organisms that have produced this enzyme catalase and so you get this effervescence.

So, the grading of the effervescence – how many bubbles are there, how quick and so on – would then be graded from 0 to 5 in their particular case that they've used there, 5 being the most effervescent and the most biofilm with lots of organisms there at that particular time. So, that is just a general indicator of the presence of another indicator, the presence of biofilm, the presence of microorganisms there, but----

Q Sorry, these don't match up precisely. So, where you've got "heavy" in the soiling column, it doesn't necessarily mean you're going to have 5 out of 5 in the biofilm column, and nor does it necessarily mean you're going to have the highest of numbers----

A Yes, that's correct, and what that means is you can't always rely on just looking at something, because the reference there to "soiling visual" is of clearly what you see in terms of visual soiling. What it does show you is that you can actually get biofilm there where you can't see obvious soiling, and so you can get some reactions where there has been no visual soiling.

So, for instance, in the-- one of the ones down that's got a biofilm reaction of 5, it says "no soiling visual." So there's an example there of where there was clearly biofilm, but it wasn't seen. It couldn't be visually seen.

Q Yes, thank you. I mean, if I were to summarise this-- if you were to summarise this, rather, it would be per your answer that flow straighteners in this hospital are heavily contaminated with biofilm as a generality. Would that be fair?

A Yes, because it looks like the distribution of these flow straighteners is from different parts of the hospital. Ward 8, ward 6, ward 2: different parts. I don't know how they match up in terms of what floor levels they're on and so on, so I'd really need a map to see that. So, if they were distributed all around the hospital, then that would indicate that the flow straighteners, possibly all over the hospital, had a problem.

Q If that were the case, then – perhaps an obvious question – but what is the problem? Where does that problem come from?

A Possibly-- there's two answers to that. It could come from-- excuse me. Initially, it could be that the flow

straighteners were delivered with contamination in them, and that's a possibility. I have seen that in other hospitals, where the contamination was introduced by contaminated flow straighteners coming with contamination already in them.

Because some taps, for instance, are pressure tested with water prior to being sent out to the places that have bought them, and certainly on one occasion where I've been to a tap manufacturer, there has been a situation where the test rig to pressure test these taps was using quite dirty water, contaminated water, and I drew their attention to this and it was an issue, really, which I think needed to be addressed.

I don't know whether across all of the tap manufacturers that has been addressed, but it can cause a problem. So pressure testing of taps can lead to residual bacteria being left within the taps, for instance, and then being shipped off to the customer and being installed with bacteria already in them as a result of that.

But the other part of that then could be, of course, that the water system itself was then contaminated or, for some reason, the contamination is located at the flow straighteners. Some flow straighteners, well, nearly all flow straighteners have some sort of structure – a mesh or whatever – which is an impediment to the flow of water, to a certain extent, and is a sieve in some ways, and can sort of take out bits of debris from the water system.

But it also-- it acts as a physical opportunity, a sort of barrier for organisms to latch on to and stay there and develop as biofilm. They'll be constantly wet, of course, because water's going over them all the time, but they can stay there and with this polysaccharide glue, if you like, that I talked about before, they have a really fast attachment to there and so they can stay there and not be washed off necessarily, yes.

Q If we move forward five pages in the reports to 522----

THE CHAIR: I wonder, before we leave the table-- Do you still have the table there, Dr Makin?

A No, it's gone.

THE CHAIR: It's certainly gone from my screen. Yes, it's the column "Estimate total count per item." Now, I take it an item is one flow straightener?

A Yes.

THE CHAIR: Yes, and a CFU?

A Is a colony forming unit, which effectively is one bacteria, is the way we think of it. It's not absolutely true because a CFU is an agar plate. If you

think of an agar plate with a colony on it – an agar plate is a colony of bacteria – normally, if you put one bacteria on that agar plate, it will grow to produce a colony. So, after 24-48 hours' incubation, it would grow and you would see it as a visible colony, so we call it a colony-forming unit.

We assume that that comes from one bacteria that has created that, but you can get, particularly where you've got biofilm, an accumulation of organisms, which could be 10 organisms, 100 organisms, 1,000 in a biofilm, and when they hit the agar plate, they still produce one colony. So you could have the origin of that colony, either one bacteria or 1,000 bacteria.

THE CHAIR: Mm-hmm.

A So we call it a colony-forming unit. We can't really say it's one colony, so you can't count it exactly as each one of those colonies came from one bacteria because what you then do is you count those colonies.

If you say 10, there was 10 colonies in the original sample. If we took 1 ml of sample, that's 10 per ml, if you like. You can say there's 10 organisms per ml of water in there. You can't say that with agar plates because, as I say, one of those colonies could have come from 1,000 bacteria, but it still only produced one colony. Do you see where I'm----?

THE CHAIR: I'm not getting all of the detail there, to be absolutely frank, but I may not require all the detail. I mean, I can see these are large figures. I'm not entirely sure whether I'm looking at 2 million or 20 million.

A 20 million in some cases, I think, yes. I think.

THE CHAIR: 20 million. It's just that I get some sort of understanding of what the test has found because, as I understand it, it is a number of microorganisms. Some may be pathogenic, some may not be pathogenic. Am I right so far?

A Yes, yes. It's a number of organisms and we don't know if they're pathogenic or not, if they're capable of causing infection or not. But what it is, it's an indication of, certainly from my experience, heavy microbial contamination.

Because normally, if you were taking a sample from a tap or you took one of these flow straighteners that maybe had not been used previously, whatever, you would only get a couple of organisms per straightener.

So the sort of count, if you like to think of it, of a normal piece of kit within the water system, you wouldn't expect heavy counts like this. You would see very low counts. You would never see nothing, probably, but you would see two

or three per flow straightener, not these sort of numbers. Does that help, sorry?

THE CHAIR: That is helpful, thank you. Sorry, Mr Maciver, you were moving on.

Q I was. (To the witness) The reason for taking you to page 522 was it gives two options: that flow straighteners may come pre-contaminated and the biofilm is already on them, or the biofilm may be getting there via the water supply. The reason for taking you to page 522 is that we see here at the top of the page a treatment was made of unused flow straighteners.

Now, certain results follow, but they're perhaps most neatly dealt with in your own statement at page 17 of the written statement, 19 of the bundle, where, in the paragraph beginning:

> "The full Intertek report contains the results of analysis of 25 unused flow straighteners that were fitted to taps and tested for bacteria over time. Prior to installation, these flow straighteners contained only small numbers of bacteria and no biofilm was detected.
>
> The flow straighteners were tested over a period of more than a month and the results showed they contained increasing numbers of a wide range of bacteria and after a month showed a 500,000-fold increase in bacteria. At this stage, all flow straighteners tested positive for biofilm and over 70 per cent were heavily positive for biofilm."

Does that clear up the question as to whether it's option one or option two?

A Yes, it would suggest that the flow straighteners as-- because they've taken unused flow straighteners here and tested them and, as I mentioned before, they were not very heavy counts. There was a low level of bacteria detected in the unused flow straighteners.

The only caveat there, the thing to bear in mind, is that if flow straighteners, let's say, for instance, had been pressure tested in the way I described before, and then maybe left on a shelf in a plastic bag or something before they were sent off to the customer, it might well be that those organisms, at that stage, as the water is starting to disappear and it's drying out, that they-- those organisms will become stressed, and so what you can get is a state of what's called VBNC, which is viable but non-culturable.

So you can get organisms which are shocked, basically, and they go into a sort of state of suspended animation, to a certain extent, and so when you do cultures on them, initially, they don't grow so readily, so you don't get a number of organisms on the agar plate to see that

those organisms are there, but they may still be there, but they're just not growing on an agar plate because they've been stressed and they need a bit more cajoling, basically, before they eventually will grow on an agar plate.

So although these flow straighteners have only got in this particular test, which was quite a crude test in some ways, because what they've taken is 200 ml of sterile distilled water, put it in a sterile plastic bag and put the flow straightener in it and then shaken it, yes?

That's quite harsh to microorganisms to be exposed to distilled water in that way. Normally, you would have much more supportive media to allow them to come through, but in using this test, it's given them the indication that there were not a lot of organisms there and that probably is the case, I should imagine, but you have to bear in mind that you can have situation where there are more organisms there than have come out in this particular test.

Q Thank you. Just for completeness, the paragraph below that:

> "The Intertek report also analysed results of water testing for each floor of the hospital and that showed an average of around 40 per cent of the samples collected from each floor were positive for bacteria and 60 per cent of samples were positive on one of the floors, the fifth floor."

What do you take from that? How widespread does that indicate contamination is?

A Yes. Well, it indicates that there's clearly widespread contamination throughout most parts of the hospital.

Q How would you translate that into level of threat to patients, and particularly to any specific patient cohorts?

A Yes. In most cases, given the organisms that were being recovered, it wouldn't be particularly dangerous to most patients in that hospital, but immunocompromised patients, as I mentioned earlier, can be infected by relatively innocuous organisms, less harmful organisms.

So this, for the general type of patients in the hospital, would not present a particular threat at this stage, but it is an indication of the fact that the system--the water system is conducive to the growth of organisms in general.

You would take from that that, at some stage, other, more pathogenic organisms might be able to grow in larger numbers, for instance, Legionella and Pseudomonas aeruginosa and so on. The organisms that they were covering here were relatively background organisms which you'd see in water systems, which, as I say, would not

bother you and I.

Q Thank you, and just largely for completeness, there's-- over the page, page 20 of the bundle, 18 of your paper copy, halfway down that page where there's an Intertek report from October of 2018.

The paragraph below that describes the report being dated
1 October and after the meeting you attended on 31 August 2018, the next meeting you attended was eight months later in April 2019, and you say that, "This Intertek report may have been discussed at one of the meetings held during that period."

Can I just-- could you just clarify, please, did you-- does that indicate that you saw that report the next time you were involved in April 2019, or am I reading too much into that paragraph?

A I didn't necessarily see that report when I next attended, yes. I can't recall when I next saw that report, but I wasn't given it at a time maybe that other people saw it. I don't know.

Q Would you have expected to have seen that report?

A Which report is this one? What are we referring to?

Q Sorry, that's the-- it's 1 October 2018. It's in bundle 18, volume 1, at page 82. (Inaudible). It's perhaps easiest, rather than scrolling through the report, if you-- if I just refer to your own description of it and back on your statement.

A Is it about-- sorry, is it about the flow straighteners again that we talked about?

Q Yes, analysis of flow straighteners, you say at the bottom of the screen, showed they're comprised of eight parts: six internal plastic parts and two rubber gaskets.

A Yes. Yes. What this report shows is that the flow straighteners are particularly complex structures, or multi-layered, shall we say – not necessarily complex but multi-layered – and that there's a lot to them and it clearly, because of the complexity of them, it's given an opportunity for organisms to stay there and reside there.

So there's a number of layers where these organisms can latch on, and so that other study that we referred to previously shows that the contamination that was there was supported by the complexity of these flow straightness because of the number of layers that were there.

Q With that being in mind, would you have expected to have seen that report at the time it was issued in October 2018, bearing in mind that that's roughly at that stage in procedures? You had lodged your reports on Clorious2, but chlorine dioxide dosing had not yet commenced.

A I would have expected to see that report and I may well have seen that report. I can't be absolutely certain when I did see it, yes. Unfortunately, the memory is not as good as it used to be, and it's six years ago, so I can't remember it with accuracy.

Q All right, I suppose the more important question is, had you seen that at the time it was issued, would it have changed any opinions or actions that you recommended?

A Not necessarily any actions recommended by me because, in fact, one of the things that sort of impressed me about all of this is the fact that the hospital was moving on in terms of looking at the possible causes of the contamination. They'd done some great work, I thought, in terms of, for instance, considering the flow straighteners and the fact that they could have been a contribution towards this contamination.

And clearly, from the results we just discussed, there was an issue there to be addressed and so contamination would accumulate at these flow straighteners, and I was impressed by the fact that the hospital had put in the effort at that stage and looked at already without me recommending this. This was not one of my recommendations; they didn't ask me about this, but obviously, at some stage later on, I was informed about this,

maybe at one of the meetings that I attended.

But this was impressive, I thought, that they'd looked at the flow straighteners and done such analysis, microbiological analysis, breaking them down, taking the samples and considering them as a potential source of contamination within the water system. So I was quite impressed by that.

Q Okay. Among the bundle documents that you got, there were, I think, two or three miscellaneous documents that I'll just have put onto the screen for you. Within bundle 27, volume 3, at page 622, there was a letter from the chief medical officer.

A Yes.

Q Have you had the opportunity to read that before?

A Yes, I got it yesterday, I think, or something like that, yes. So I have been through it, yes.

Q Broadly speaking, I would summarise this as being the raising of an issue at a high level within NHS Scotland, informing the Trust of actions they should take. If we see in the background section in the middle of that page, that relates to incidents of Pseudomonas-related infections reported across the UK where the source of infection is thought to be related to hand-washing facilities. If we go on to the next page, we see the last of

the directions or suggestions:

> "Ensure all taps are flushed in accordance with the attached best practice for hand wash basins to minimise the risk of Pseudomonas aeruginosa contamination in high-risk units."

A Yes.

Q Right, so that letter was from April 2012, I believe. I wonder, can we go back a page to see the dates actually on it? February 2012. The next document was within bundle 3 at page 5. This was SBAR documentation. This is internal document recording consultation process between Greater Glasgow and Clyde and Health Protection Scotland seeking advice and, in short, this is about--

If you see the assessment section-- or rather the situation describes this as being the requirement to remove flow straighteners from the taps procured for the new Southern General Hospital. You may or may not be aware of that, but Southern General Hospital is the name of the hospital that was formerly on the site. It's now the Queen Elizabeth Hospital.

In the background is a description of the-- a particular Horne Optitherm tap with flow straighteners, and the assessment, the second bullet, is focusing upon current guidance in minimising the risk of Pseudomonas aeruginosa infection from water.

If we look at the next page, there are three options mentioned as regards the tap installation, and bearing in mind that the hospital is being built at the time, the three options are either that the procured taps can be installed with a water sampling regimen, two modifies that slightly in that it's-- the procured taps be installed in clinical areas, excluding high-risk units with procured taps without flow straighteners in high-risk units, and the third option was to install secure taps in the clinical areas with new compliant taps in high-risk units without flow straighteners.

If we go down to the recommendation, the recommendation is either of the second or third options. So that was from April 2014, and the last document I referred you to was in bundle 15, page 692, and this is----

THE CHAIR: (Inaudible). I'm just wondering if I'm keeping up. The document we've just been looking at, you introduce as an SBAR, is that correct?

A Yes.

THE CHAIR: Right. Do we know anything more about that document?

A The date is not, I think, on it, but it's from April 2014. I'm not sure I have any other further details to offer.

THE CHAIR: Right, okay. So we've had-- we don't know the author?

A No.

THE CHAIR: Right. Thank you.

Q The document I'm referring you to now is the minutes of a special meeting of 5 June 2014, and if we scroll down slightly, we see at section 2 that the background is a series of incidents in Northern Ireland. Pseudomonas was an issue, and then the next paragraph:

> "Among the recommendations was advice that flow straighteners/aerators/rosettes should not be installed within taps in accommodation occupied by vulnerable (immunocompromised) patients."

If we go down to the next page, I think probably one page further on – it's section 5.3 – you see the outcome of the meeting:

> "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 risk would form part of the routine management process."

Now, again, I remind you, that was June 2014. Now, against that background, those documents from 2012 and 2014, you mentioned that you were impressed that there had been digging into flow straighteners in 2018. Does that change your view as to how impressed you might be as to the amount of analysis that was being undertaken in 2018?

A Well, it sort of indicates where the idea came from, in a way, because obviously there was a focus on flow straighteners and the various documents you mention there were talking about flow straighteners and the risk they present to water systems, and so the analysis of those flow straighteners undertaken by the hospital was appropriate to do that.

I suppose all it did, really, in some ways, was confirm all of this, that flow straighteners, particularly more complex flow straighteners, can be a source of contamination in the water system. Very difficult, in my opinion, to get rid of, unless you get rid of the flow straightener.

Q Thank you. At this point, can I take you to your reports on Clorius2? Now, we've discussed Clorius2 in a little bit of detail already – it's bundle 27, page 503 – so I don't need to look at this in considerable detail. In the introduction section, you introduce by saying:

"Following the identification of hospital-acquired infections, Cupriavidus and Stenotrophomonas [it's QH], and the detection of those bacteria in various parts of the hospital's hot and cold water systems, it is considered necessary to treat these water systems with a residual biocide."

Do you know who made that decision?

A I believe it was the Incident Management Team.

Q The way you record it here is, "It is considered necessary." It's passive tone here. From what we've discussed so far, can I take it that you agreed with that decision on the basis of your knowledge at the time?

A Yes, I agreed, and still agree, that it was appropriate to be using a biocide in that water system and, as I said earlier, I think a biocide should have been used even earlier, at the point of instruction, yes.

Q The bulk of this report deals with the Clorius2 system, which I don't think I need to go into, but I will ask you some questions about chlorine dioxide generally. Is it correct to describe that as a blanket approach in tackling a microbial outcome rather than attacking the underlying causes by which microbes might come to be present in the water system?

A No, I wouldn't consider it as a blanket approach, no. I would say that the two have to go hand in glove. You can't really just apply a biocide and hope for that to solve all your problems when you've still got the underlying issues that need to be addressed – very often engineering ones. So it's necessary to do both to make sure that any inadequacies within the system are addressed from an engineering perspective or whatever, and that the biocide is applied at the same time.

Q Does the same hold for any biocides?

A Yes. Yes. Yes, there's no panacea out there, unfortunately. There's no biocide which will solve all of the problems. Chlorine dioxide, in my opinion, is one of the best of them, but even-- and it's done some very good work and, as you've seen from the Royal Liverpool Hospital and from the cardiothoracic centre in Liverpool and from the Glasgow Royal Infirmary, where it was used in a six-year study-- that it managed to address the problem of the outbreaks of Legionella, Legionnaires' disease in that case. But, as I say, they don't solve all the problems and you have to make sure that you address the underlying issues or you will keep having a problem.

Q Is chlorine dioxide targeted against specific organisms, or is it, in the nature of a biocide-- does it target biological material?

A It's the latter, yes. You tend to-- you attack anything. In this case, chlorine dioxide is an oxidising biocide. An oxidising biocide will oxidise anything: any organic matter, effectively. If that happens to be an organism, then it can kill it.

Q Does it follow from that, then, that it also carries risks to patients?

A It also has what, sorry?

Q Carries risks to patients, human beings?

A Oh, yes, it does, yes. There are guidance on what levels of chlorine dioxide you have to put in a water system because if you go above a certain level, then it can be harmful to people, yes?

So the drinking water inspectorate, for instance, applies a standard with regard to chlorine dioxide and says you must not go above 0.5 parts per million in drinking water, and so we shouldn't be imbibing-- we shouldn't be drinking levels of chlorine dioxide above 0.5 part per million.

It may be necessary in some circumstances to exceed that level; it depends on which is the biggest risk. If you've got a situation where you've got organisms threatening people in a

building, particularly patients in a hospital, for instance, you may choose to go above that level where you would have to take the necessary safeguards. For instance, say that the water then is no longer fit for drinking because you are more concerned maybe about the microbiological risk, and therefore need a higher level of chlorine dioxide--

But, in most cases, if you address most of the engineering issues as well in the background, you would-- in my experience, you would normally find that levels up to 0.5 parts per million and, in most cases, with most organisms – not all organisms but most organisms – affect a certain level of control, sufficient control, so that you feel you are managing the risk----

Q Without making it dangerous to patients?

A Yes, yes, so you're complying with the regulations in terms of less than 0.5 parts per million.

Q Now, in the context of a hospital, where there are particular types of patient cohorts, does that hold across the board or are there particular cohorts that there are particular measures that are necessary?

A There are. When you are considering using a biocide such as chlorine dioxide, and some other biocides as well – silver and hydrogen peroxide,

for instance – you have to be particularly careful about certain classes of patients – for instance, renal dialysis patients – and you have to sort of make sure that chlorine dioxide or these other biocides are not getting into the units that would be using that water safe for renal dialysis.

Equally, some babies may be susceptible to some of the degradation products from, for instance, chlorine dioxide, like sodium chloride, for instance, and so you would protect those particular units – renal dialysis unit and neonatal units, possibly – from exposure to chlorine dioxide.

Q The other side of the coin that I have in mind is a reference you made earlier in your evidence to the effects of biocides being reduced, I think you said, 100- to 1,000-fold if biofilm were present, and that was because of the kind of glue substance, as I understood it.

A Yes, that's right.

Q -- (inaudible) operation.

A Yes, that's right.

Q What I'm interested in is what are the implications of this in an occupied hospital specifically? How do you eradicate or adequately treat biofilm safely in a hospital that's occupied with that increased effect in mind?

A The answer is it's difficult and it takes time. It's one of the reasons that it's always mentioned, and I think it's

mentioned in some of the evidence that were provided in the bundles, that it's going to take time for chlorine dioxide to work in this situation because you are slowly wearing down the biofilm, which has accumulated over whatever period of time. You are slowly trying to reduce it and that's because you can only go up to that level of 0.5 parts per million.

One of my recommendations when I agreed with them about the use of chlorine dioxide in this hospital is that they should use-- prior to the introduction of continuous dosing with chlorine dioxide, that they use shock treatment as well, which is higher levels of a particular biocide – could be chlorine dioxide, could be chlorine. Higher levels----

Q Did you recommend that at Queen Elizabeth?

A Yes, I did, yes. In my recommendation, and I think it's in some of the minutes of some of the meetings that I did attend-- of the eight or nine meetings I did attend, where I've suggested that they should be using shock dosing first, effectively to soften up the biofilm that had accumulated over a certain period of time.

That can help, certainly, with the higher levels of the biocide, and if, let's say, for instance, we use chlorine dioxide, the higher levels of the biocide would help to kill off some of the organisms

there but would also help to detach some of the biofilm and get rid of it from these environmental niches where it had started to develop.

So, it's important really, and certainly in the advice that I gave was that shock dosing with higher levels of biocide would be used first, and then continuous dosing with lower levels would be used on a continuous basis thereafter. But it was, certainly and understandably--the point was made to me that it would be too risky to use shock dosing or too difficult, too intrusive, to the normal running of the hospital to use shock dosing and I fully understood that, and if you can't do it, you can't do it.

It's ideal, really, if you can do the shock dosing before the patients come into the hospital. You know, this is the bit I was talking about earlier. If you use higher levels at that point, you can use much higher levels that the system can stand in terms of the stainless steel, what can that cope with in terms of the amount of biocide and so on, but you don't have to worry about patients at that stage. After that, you are limited to what you can use and so it takes time to do it.

Q Thank you. My Lord, I have one or two questions left to ask, but I'm conscious that there's often a short break just before we finish for the morning in case there are any further questions that core participants may wish to put.

THE CHAIR: Right, so would you propose that we take a break now for you to ascertain whether any other questions are necessary, or do you want to continue?

Q Take a short break now, perhaps five minutes rather than ten, and then I can do a sweep up and be finished not long after one o'clock. Ten minutes, perhaps?

THE CHAIR: Dr Makin, we want to find out if there's questions coming from the floor, so we'll take five or ten minutes' break, so could I ask you to go back to the witness room and you'll be coming back shortly.

A Yes.

(<u>Short break</u>)

THE CHAIR: Mr Maciver, what do you propose?

Q My proposal is that I have one substantive question and two very short additional questions.

THE CHAIR: Well----

Q I would propose that we review these just now.

THE CHAIR: -- should we just sit on?

Q Yes.

THE CHAIR: All right.

(The witness re-entered the room)

THE CHAIR: Mr Maciver?

Q Thank you. I hope we can be very brief. I've got one substantive question for you, which will require looking at one of the minutes for one of the IMTs. It's in bundle 1, page 322.

THE CHAIR: Sorry, could you give me that again?

Q Bundle 1, 322. Yes, thank you. Now, the actual details of the meeting I don't think we need to go into, but the point I'm interested in-- there's a reference in the top paragraph on this page to a suggestion being made by one of the participants at TI----

THE CHAIR: Sorry, just so I'm keeping up. This is a minute of an Incident Management Team meeting on 19 June 2019?

Q Yes, that's correct. Apologies, my Lord.

THE CHAIR: Right. Thank you.

Q The particular reference I'm interested in is at the top of page 322, and one of the participants at TI explaining that:

> "Chlorine dioxide has been very effective against gram-negatives but atypical mycobacteria persisting, they are likely more resistant to disinfection."

One of the mycobacterium which have arisen as an issue at Queen Elizabeth is an organism called Mycobacterium chelonae. Are you familiar with that organism?

A Yes.

Q Are you able to comment on the suggestion made there that it may be more resistant, in which case the question is would chlorine dioxide successfully control or (inaudible) chelonae?

A Yes, I think there's another thing to take from this as well, if I may----

Q Yes.

A -- is that the chlorine dioxide-- "TI" explained that chlorine dioxide has been very effective against gram-negatives, and gram-negatives are the other organisms that we've been talking about, the gram-negative organisms which, in some cases, has caused infection in some of the patients, and the gram-negative organisms which were causing contamination of the water system.

So it's nice to see that in fact there's reference there to the fact that chlorine dioxide has been effective against gram-negatives in that. Presumably, by what they're saying there is that it's reduced the count of gram-negatives in the water system.

So that's interesting because, certainly from my perspective, I didn't see

an awful lot of references to the efficacy of the chlorine dioxide, and this is an example where it obviously has done something; it's reduced the gram-negatives. They seem to be relatively impressed by that, but they're making a statement, as you refer to there, but atypical mycobacteria are persisting, yes.

There is an intrinsic resistance within atypical mycobacteria to-- generally to disinfectants and to, for instance, antibiotics as well. They can resist the penetration of these agents into them because they have a sort of waxy, mycolic acid coat, lipid coat, on the outside of these organisms, which acts as a sort of physical barrier in some ways to the penetration by antibiotics and by disinfectants as well.

So they are sort of hydrophobic organisms. In a way, ironically, they shun water, but in doing so, it causes them to head for surfaces and stick on the surfaces, effectively protecting themselves on the water, if you like, certainly on one side at least, and then they produce their biofilm around them to further protect them.

So they are organisms which are, to a certain extent, are called biofilm pioneers, in a way. They like to head for surfaces and stick on surfaces and stay there even better than some of the other gram-negative organisms that are

referenced there. So, these mycobacteria really do have the ability to be able to stay and live within a water system quite well and adhere to that water system. Sometimes very difficult to get rid of them.

As I sort of alluded to earlier, this sort of extra layer – the biofilm, and particularly the sort of lipid layer, this waxy coat layer that these organisms have – it makes it difficult for biocides to penetrate it, so they can survive better. It is true to say that if you use high enough concentrations of biocides you probably could eradicate them or reduce them significantly. You can never eradicate, but you can reduce them.

But at the levels that you are using in a in a potable water system, a hot and cold water system – the levels of, let's say, no more than 0.5 parts per million-- As you can see here, there has been a reasonable effect on the gram-negative organisms, but this person is saying that they, the mycobacteria, have persisted. That's because of this intrinsic resistance that they have, and so they can protect themselves and will tend to hang on a bit longer.

But it's true also to say that-- You could say that, selectively, if you were doing analysis on water samples and you found these mycobacteria there, it could also be due to the fact that, in this

particular case, that the gram-negative organisms have been reduced, and so there's no more sort of competition, competitive inhibition, if you like, with the mycobacteria, so it's easier to detect the mycobacteria in the absence of those other organisms, if you see what I'm saying.

Q Okay. Thank you.

THE CHAIR: Am I right in thinking that Mycobacterium chelonae is gram-positive?

A It's a-- It is a----

THE CHAIR: Or is that not the right question?

A Well, no, it's a reasonable question, yes. I believe it is. I actually can't remember, actually, whether it's gram-positive or gram-negative, but it is a rod-shaped bacteria, yes. It tends not to be gram stained, which is one of the reasons why I hesitate on that----

THE CHAIR: All right.

Q -- particular question, because it's an acid-fast stain, a different type of stain that's used to identify mycobacteria, something called initially the Ziehl-Neelsen stain, which differentiates on the basis whether that stain is acid-fast or not, so it's different from a gram stain.

THE CHAIR: All right, but the characteristic of the Mycobacterium chelonae, which you were explaining to Mr Maciver, the lipid coating, I take it that's quite a separate matter from how you identify by staining?

A Yes. Yes, I mean, that seems to be a facility of all mycobacteria. They all seem to have that ability to be able to produce that biofilm, and it's because of that lipid coat. That lipid exterior makes them want to form together and produce colonies, effectively.

It's sort of-- because of the hydrophobic nature of them, it sort of shuns water. It will head for surfaces and stay there, so it is very good at attaching to surfaces and very difficult to remove once it is established, yes.

THE CHAIR: Thank you.

Q Yes, only two last questions. The first one is really procedural. I didn't take you to your tap report at all. You've addressed that at answer 15 of your statements. My only question for you is, we can read that for ourselves, do you still stand by that report?

A This is the tap-- the automatic taps versus the manual flushing?

Q Yes. Yes.

A Yes, I have no reason to disagree with it, yes.

Q Thank you. My concluding question, then, in that case, is that at question 18 on page 39 in the bundle, 37 of the written statement, you were asked for additional comments and you address certain matters. You start out by referring

to there being no standards of guidance other than the ones pertaining to Legionella and to Pseudomonas.

A Mm-hmm.

Q Is that still your view?

A Yes. I don't see any other standards for these other organisms. For instance, what is an acceptable number? So we have very defined guidance now, very detailed guidance on what constitutes an unacceptable number of Pseudomonas and an unacceptable number of Legionella, for instance, but there is virtually nothing on other organisms.

Q Thank you. You do mention a few other matters in that answer we can read for ourselves. Sewage, I've already taken you to. I think we've addressed continuous dosing. Is there anything else arising from that answer that you'd wish to share with us?

A Anything from this answer?

Q Yes.

A Can I just find it on the-- So what's the page number as I see it?

Q It's page 37 of the written statement.

A 37? (Pauses to read document) Yes. Yes, I think I've made the point there in that answer, really, which is what I stated at the beginning-- is that one of the issues, I think, which this particular hospital unfortunately has

fallen foul of is the fact that there was no specific guidance to do routine testing for Pseudomonas aeruginosa, and had that been there, it might have helped them earlier on. So, that was a particularly relevant point, and I thought, possibly, when the Scottish HTM is rewritten, they may want to reconsider that. It would be my suggestion with regards to that.

Q Thank you. I have no further questions, my Lord.

A Is that all you wanted from me with regards to this particular answer or do you need me to----?

Q No, that was all I had.

A Okay.

THE CHAIR: I take it that there are no further questions for Dr Makin? Dr Makin, thank you very much. Thank you for attending today and the travel that that will have involved, but also thank you for the amount of preparation, which I imagine will have been considerable. I'm very grateful. Your evidence will be of assistance to the Inquiry, and I thank you for that, but you're now free to go.

A Thank you very much. Thanks. Thank you.

(The witness withdrew)

THE CHAIR: I think we might sit again at ten past two. Right, well, take until ten past two.

(Adjourned for a short time)

THE CHAIR: Mr Maciver, I understand the next witness is Mr Kelly?

MR MACIVER: Dennis Kelly, yes, my Lord.

THE CHAIR: Good afternoon, Mr Kelly.

THE WITNESS: Good afternoon.

THE CHAIR: As you understand, you're about to be asked questions by Mr Maciver, but before then, I understand you're willing to take the oath.

THE WITNESS: I am, yes.

Mr DENNIS KELLY
Sworn

THE CHAIR: Thank you very much, Mr Kelly. Now, I don't know how long your evidence will be; I would anticipate it might take us to four o'clock. But if, at any stage, you want to take a break for any reason whatsoever, just indicate that to me and we'll take a break. Now, Mr Maciver.

Questioned by Mr MACIVER

MR MACIVER: Thank you. (To the witness) Could you tell the Inquiry your name, please?

A Dennis Kelly.

Q And who do you work for?

A I work for Pro Lp Consulting Ltd.

Q And what kind of business is that?

A It's a one-man – me – consultancy, water consultancy company.

Q Right, thank you, and among your consultancy services are being an authorising engineer with the NHS, is that correct?

A Correct.

Q Since when have you been doing that?

A I think-- I had a look back. The first time I think I did authorising engineer work was when it was first introduced as a concept, and that was around about 2010, 2011.

Q And how did that get introduced as a concept?

A The NHS use external experts, to use their phrase, to support principally the Estates people on a variety of different elements: medical gases, decontamination, ventilation and water. And the water one, as far as I'm aware, started around about 2010. There have already been authorising engineers for electricity, for example, at that time.

Q Is there a specific requirement to have an authorising engineer for water? And if so, (inaudible)?

A Yes, I think the boards are told

that they should employ authorising engineers, yes.

Q What did you do before you took up with Pro Lp Consulting?

A I've been in the water treatment business for 47 years, originally in technical sales then through various management roles until about 15 years ago, when I was made redundant. I had a senior management role looking after a water hygiene business in Europe for a large American company and then I just started working for myself. But throughout all the roles, I always maintained my kind of technical input because I enjoyed it, frankly.

Q As you said, your current roles include authorising engineer for water in a number of places in Glasgow, as I understand it. Is that correct?

A In Scotland and outside of Scotland, yes. So I work for about-- I think it's nine or ten NHS boards in Scotland as their water authorising engineer, and I do the same for a number of other companies that supply and run the PFI-type hospitals.

Q How many hospitals do you act as the authorising engineer at?

A That's not an easy question to answer. If you went to each board I work for and look at the hospitals, it will be in the hundreds, but invariably in a board you might only be involved on a day-to-

day basis with four or five. You know, principally the acute hospitals, but they'll have multiple buildings like health centres, non-acute hospitals like care for the elderly and mental health, but the focus is generally on the acute hospitals. It does spill into the other ones as well, but mostly in the acutes.

Q One of those hospitals is the Queen Elizabeth----

A Yes.

Q -- University Hospital in Glasgow, and since when have you been the authorising engineer there?

A I started in 2011, looking back at my records, as AE Water, and at that time I was working for another consultancy called Legionella Control International Ltd. That's a Legionella consultancy that use-- that have a number of consultants, but all the consultants were self-employed, but we wore an-- LCI, we call them. We wore an LCI hat to do the work for them.

Q Okay, my question was about when-- since when you'd been the engineer at Queen Elizabeth Hospital.

A Oh, I'm sorry.

Q Yes. I think I've got (inaudible).

A That would be around-- I was doing AE work for Glasgow from 2011, and in terms of the Queen Elizabeth, it would be around about 2016, 2017,

something like that. I did the first audit in May 2017.

Q Okay, thank you. Now, before we go any further, I should remind myself and yourself that you have a witness statement with the Inquiry. You've signed that. Can I just ask you, are you content to adopt that as your evidence?

A I am, yes.

Q I will ask you certain questions based around your statement and also certain questions based around other documents. You've had a document list to familiarise yourself with. Where I refer to those other documents, they'll be shown on the screen in front of you.

A Okay.

Q Now, before I interrupted myself, you told us you were appointed as authorising engineer at Queen Elizabeth around the end of 2016. Would that sound right?

A I was the authorising engineer for water for NHS Glasgow before that----

Q Okay.

A -- but they had never asked me for any involvement at the Queen Elizabeth until late 2016, 2017.

Q Now, you mention in your statement that when you were appointed authorising engineer for water at Queen Elizabeth, one of the things you did was to recommend an audit, and you've already mentioned the audit.

A Yes.

Q And I think you say that you made that recommendation within your annual report.

A I did.

Q Is that correct? Can you tell us about that annual report? What was the nature of that document? Who was it to? In what capacity were you writing?

A That report actually went to Alan Gallacher, and part of the role of authorising engineer is to do an annual report. Most of the work in those days that you did was done on request. You weren't given a set of tasks at the beginning of the year and said, "You'll do this in January, you'll do this in February." It was basically by request, and in the report that I did for 2015, 2016, I was conscious that the Queen Elizabeth was up and working.

I had not been asked for any input. You don't want to be seen to be pushing your way into things – I'm not an NHS employee, I don't want to be seen to be taking advantage of my role there for business reasons – but I did make the recommendation that it should be audited.

Q Okay. So, to be clear, that report you're talking about in 2016, was that specific to the Queen Elizabeth Hospital?

A No, it was for NHS Glasgow.

Q Thank you. Can you tell us what, in general terms, what the role of authorising engineer involves?

A There's a number of facets to it. One is to offer technical support when needed and some boards use me almost on a daily basis, some don't use me so much. So there's technical support, you do compliance audits, which tend to be done on an annual basis to look at the-- and the compliance or it looks at how the water systems are being managed. It doesn't necessarily drill into the detail that, say for instance, a risk assessment document would.

Another facet of it is authorised person competency checks, so I look at NHS staff, people who are appointed as authorised persons for water and I check their competency and give a view as to whether I consider them competent enough to hold that role.

Q Would you be involved in microbiological matters involving water?

A Yes.

Q Including things like interpreting water sampling results?

A Well, I see a lot of sampling results. I'm a biologist by background, by degree, so that's my background. I have a biological degree.

Q So you actually do have qualifications for----

A Sorry?

Q You do have qualifications for that particular task?

A Yes, yes. Yes, and I've had 40-odd years' experience of working with bacteria and various types of water systems.

Q Now, you mentioned among the last answer-- There was quite a lot in it, but one of the things I took from it was that your degree of involvement among hospitals can vary wildly.

A Yes.

Q How do you manage your work?

A A certain amount of it is pre-programmed, so for GGC now, I have audits in my diary up to the end of the year. In 2015/2016, it was, "Can you come and do an audit?" And so I-- I'm more or less full-time. I'm not 100 per cent full-time, so I do manage to fit everything in generally without too much problems.

Q How do you ensure that you do have enough time to do your hundreds of hospitals?

A Well, you don't get asked to audit hundreds of hospitals. You tend to get asked to audit the major acute hospitals. I think Glasgow is five, so Lanarkshire had three, for example, when I worked there, so that was where the focus was.

Q Do you know how it came

about that you were contacted to become authorising engineer at the Queen Elizabeth?

A Well, as I said, I was already the authorising engineer for NHS and GGC, so there's an element of word of mouth. That's how the first jobs I got which were-- the first one was Tayside, NHS Tayside, and that was a phone call that I got: "I understand you work for yourself." I was known in the industry, basically.

I did, you know-- I present a lot at conferences and seminars and troubleshoot for people, so that's how it originally came about and then once I did Tayside, I think Lanarkshire asked me to do it. Eventually, NHS NSS, which is National Services and Supplies, put a tender out for the authorising engineer role for water for the whole of NHS Scotland, so I tendered for that. At that time, the Legionella Control International had pulled out of wanting to do the AE work in Scotland, so I tendered as Pro Lp Consulting Ltd and I was successful with that tender.

Q Okay, what I'm interested in specifically is you became-- Queen Elizabeth Hospital opened around April 2015 and you told us that you were appointed authorising engineer for water at the end of 2016. Firstly, there's a requirement to have an authorising

engineer for water. That's----

A Mm-hmm.

Q Is that correct? My question is, I suppose, do you know what prompted you to be approached at the end of 2016? Or rather the first question is, are you aware of anyone having undertaken the authorising engineer for the water role before you did it?

A No. I'm not aware of that, no.

Q Are you aware of what prompted somebody to decide that an authorising engineer for water should be appointed, and it happened to be you?

A So, just to be clear, you're not appointed per hospital, you're appointed per board, so I was already an authorising engineer in Glasgow at that time. I just had not been asked to do any work at all during the construction phase or the design phase or the handover phase or commissioning phase of the Queen Elizabeth. I had no involvement until after I mentioned it in my annual report. So that may have been the prompt, but I don't know.

Q Right. Thank you for that.

A It was one of the recommendations in the report that they do a compliance audit.

Q Can you tell me about the audits, before we go on to the process? Is there a specific requirement that an audit be carried out?

A It's-- part of the brief that an authorising engineer has is to do compliance audits.

Q Does that come from any sort of source, any guidance?

A NHS Scotland.

Q Once you were engaged at Queen Elizabeth, how much of your time is taken up or was taken up at any particular times with dealing with that hospital?

A To do the audit, the first audit, at the Queen Elizabeth, working – it's a number of years ago now, of course – it's probably about four or five days, maybe six days. So part of it on site, gathering data and information based on a question set that I use, and then a few days doing the report writing. That then goes back to the NHS and they review it and they come back to me with comment or whatever.

So you have that initial five or six days, and that's long. The Queen Elizabeth, it was the very first time, so there was a lot to look at and go through, so that took probably four or five days, working from memory. Other than that, I would be asked to do authorised personal competency checks. They take two or three hours per person and it would tend thereafter to be responding to requests for technical support if they had any issues that they felt I could help with.

Q So is that, in fact, an easy answer to my question, or is it just simply ad hoc?

A There's no easy answer, I'm afraid, and it's different board to board, so one board will use me on all the projects or the new builds, for example, while another one won't. One board might use me for almost every Legionella-positive result they get, irrespective of what building they find it in, other boards don't. You know, they say they've got enough expertise in house, I guess, so they just handle that themselves. So it's very varied.

Q Okay, and is it-- No, that's fine. When you were working for Queen Elizabeth Hospital, who did you report to?

A The work request usually came from Alan Gallacher and occasionally it would come from some technical support from a sector manager who was maybe responsible for a group of hospitals and there was the odd time they would get a Legionella positive and they would say, "I've got a positive, Dennis. I'm thinking of doing this, this and this. What do you think? Is that the right way to do it? Anything else I could do?" So there would be a little bit of that, but, with the Queen Elizabeth, it was Alan Gallacher

Q And just to ask you a little bit more, just to get the nature of your role

clear, really, one of the pieces of work that you'd regularly undertake would be an audit?

A Mm-hmm.

Q Once you had carried out, say, an audit, to what extent would you have any control over what happened as a result of that piece of work, or is it not that kind of job?

A It's not that kind of job. I essentially-- the audit report goes back and there'll be a set of recommendations, and in some hospitals it's two or three, in some it's 50. It depends on, basically, how they're operating the water system against what the compliance documentation asks them to do.

Once it goes back to the client or the NHS, they can run with it or they can-- You know, I've got no executive role in the NHS, so it's up to them what they do with that document. I have reviewed them, though, from time to time and NHS Glasgow has asked me to review them from time to time, but I couldn't tell you-- not every year, but I couldn't tell you exactly the years.

Q So if, for example, you were to make a recommendation that a particular piece of work be done, it would not be part of your role to follow up to chase to make sure that that was done?

A No. No, but in the following year when I do the audit, you know, you would see if that-- So, for example, one of the recommendations for the Queen Elizabeth was to get an up-to-date risk assessment completed. When I went the following year to do the audit, it had been done, so, you know-- and that was noted in the audit.

Q Okay. Well, I'll come on to the audits, as you may have anticipated, in due course. Before I do that, you mentioned that, of course, you're not an NHS employee. In general, would you consider it to be an advantage or disadvantage to be an employee or not an employee if you were carrying out the role of authorising engineer for water?

A I think the NHS take the view that independent support can be useful. Sometimes they may not have the expertise in house, so they have to go outside for it anyway, but there is an element of, if you do your own AE work and you do your own audits, you're kind of marking your own homework, to a certain extent, and they try to avoid that.

Q One of the things you mentioned there was being able to bring other expertise to the role. For example, could you outline what experience you might have had with outbreaks or bacterial issues?

A I've worked on quite a number of outbreaks. The last big outbreak in the UK was actually in Edinburgh, and I was

acting as an expert for two of the named companies that were suspected of having caused that outbreak.

I've worked on outbreaks in various cities in the UK and in Europe as well, in Amsterdam, for example. These have all been Legionella-related issues. I've worked on Pseudomonas-related issues because they came to the fore more recently in various hospitals in Scotland where there's been maybe clusters of Pseudomonas-- patients with Pseudomonas infection and they're trying to track the source down.

Q Okay, thank you. I'd like to ask you a few questions about the hospital prior to your involvement, appreciating that there may be limits to the extent to which you can answer.

A Mm-hmm.

THE CHAIR: I wonder if I could interrupt, Mr Maciver? (To the witness) Are you familiar with the terms of the Scottish Health Technical Memorandum 04-01?

A I am, yes.

THE CHAIR: Yes. It's just clarifying the authorising engineer role because that is a defined position in terms of Part B.

A It is.

THE CHAIR: Yes. So, I mean, I have to apologise for being so pedestrian about it.

A No, that's fine.

THE CHAIR: I mean, you're not a small a "authorising," small e "engineer." You're a capital A, capital E, and you're a point-- or rather, let me put it this way: in terms of SHTM 04-01, a health care authority is required to appoint an authorising engineer----

A Yes.

THE CHAIR: -- among other people.

A Yes.

THE CHAIR: And so an authorising engineer, first of all, is required and, secondly, is working within a regulatory framework.

A Yes.

THE CHAIR: Yes. Although particular tasks, no doubt, will depend on being asked to carry them out?

A That's correct, yes.

THE CHAIR: Right, thank you.

Q Now, I'll take you to your written statement, which is at page 49 of the electronic statement bundle. I didn't ask you if you were working from the-- if you were happy to work from the screen, or----?

A That's fine.

Q If you are, that's fine, yes. The top two questions there are about the commissioning and validation process.

A Yes.

Q I wonder if you can explain, in

brief terms, what that process is?

A Okay. As I said earlier, I'm not a commissioning engineer, although I do work with commissioning companies. Effectively or essentially, a water-- if we stick with water system, the water system will be put together by a mechanical-- an M&E, mechanical and engineering company, and it can be extremely complex and there's lots of elements to it and miles of pipework, and they'll come a day when it's filled with water for the very first time. It's leak tested and there's a few processes that they go through.

But, prior to handover, a commissioning company will go in and ensure that the water is flowing where it should be flowing, that the temperatures are correct, that it's reaching all the-- you know, water is not what we call short-circuiting and leaving stagnant areas of pipework.

Effectively, they are trying to sign off on the fact that it's meeting the design intent, which is a properly working water system. So, when it says "balancing" on there, for example, that's if you had a four-storey building and you were looking at the hot water system, floors one, three and four might operate perfectly well and the temperatures are fine. Floor two might not because there's a valve partially shut somewhere or something like that, so their job is to look at that and

make sure that's not the case and that the system is operating as per the design intent.

Q So hooked up and operating together the way it should be?

A Yes. Essentially, yes.

Q At your answer to question 30, you set out some of the things that ought to be checked or done.

A Yes.

Q Do you know-- and I appreciate you weren't involved with the Queen Elizabeth at that time, but do you know whether those things actually were done in respect to the water system?

A I know there was a commissioning company involved. It was a company called H&V Commissioning, I believe. Other than knowing they were involved, I'm afraid I don't know what they did. I was never-- At that time, I wasn't involved with the Queen Elizabeth at all, but there was a commissioning company, yes.

Q Then, at your answer to question 31, the question there was about specific actions you'd expect to have been undertaken before and after handover, and you set out certain matters relating to operation, disinfection and so on. Do you know whether those things were done?

A Going by the audit I did in May 2017, on 4 May 2017, some of the

expected risk reduction actions that you would have liked to have seen in place weren't. The normal-- the classic route, if you like, to delivering water systems operating in a way as low as practicable is to do a risk assessment first, then use the findings of the risk assessment and the guidance documents, which are there to help you, to define the required risk reduction processes and procedures that you should be going through to keep the level of risk low.

You can't remove the level of risk completely – there will always be bacteria in the water coming into the water system – so we have to operate the system in a way which minimises the opportunity for those bacteria to grow and develop to counts which may be problematic for patients and staff. So I would have expected various tasks to have been in place at that particular point in time.

Q But, on your audit, it appeared that wasn't the case.

A I look-- When I do the audit, I actually ask to see the records of task completion and that there are multiple tasks. It's not, you know, two or three simple things. It's flushing, taking temperatures, inspecting tanks, cleaning and disinfecting shower heads, flushing calorifiers. It goes on and on and on. I like to go back 12 months in the record system to see that there's evidence that these things have been completed, and not all that evidence was there.

THE CHAIR: Was there any evidence there?

A There was some there----

THE CHAIR: Right.

A -- but there were significant gaps and they're highlighted in the audit.

THE CHAIR: I mean, I appreciate this is not a memory test, but are you able to help us with-- I mean, we're talking about your audit in 2017.

A Yes.

THE CHAIR: You've identified, in broad terms, things that you expect to have been done, really, at the point of handover, I think.

A Well, at the point of handover, the water system should be handed over in a safe condition.

THE CHAIR: Right.

A The NHS takes ownership and they have to carry that on. I'm not aware of what went on in the run-up to the handover, although, because of my involvement, you know – and I was listening to Dr Makin this morning, who I've worked with a lot over the years, you know – possibly not sure that the things that should have been done were done.

So, point of handover, I'm not sure what condition the water system was in. If the water system was in very good condition, there should still have been

risk reduction processes and procedures in place. If it wasn't in a good condition microbiologically, there should have been a combination, in my opinion, of remedial action to get it to an acceptable stage and then the ongoing risk reductions thereafter.

THE CHAIR: Right. In 2017, were you able to identify things that you would expect to have been done post handover that weren't done?

A I think so, yes. If you just give me-- Yes, I should have----

THE CHAIR: I mean, unless I'm taking this out of order.

Q Well, if it assists, I am going to take Mr Kelly to precisely that document.

THE CHAIR: Right, very well. (To the witness) Maybe I should just leave you in the competent hands of Mr Maciver.

A Right, okay.

Q We may look at that, but it's some length, so-- Before we go there, we got onto that passage of evidence really by asking about things that might or might not have happened in commission and validation.

A Mm-hmm.

Q A related question relates to an incident a few years later in relation to the Schiehallion unit.

A Schiehallion, yes.

Q You're familiar with incidents

around that unit in 2018?

A It depends. It depends if I was involved in the incident. I may have been, yes.

Q Specifically, I'm interested in the closure and refurbishment----

A Right.

Q -- of that unit from end of 2018 onwards. Having detailed the things you would expect to have seen before and after handover, are you aware of whether those things happened in the Schiehallion unit before it was reopened after having been closed for refurbishment?

A Okay. In short, no, or partially, I suppose, because when you look at the----

Q Do you mean "partially aware" or "partially things were"----

A Partially completed, I was talking about----

Q Thank you.

A Because the record systems are for the hospital and you can look at individual parts. I don't think I looked specifically at the Schiehallion unit. I took an overall view to try and get a feel for how the hospital was operating its water systems when I did the initial audit.

But no, I mean, I'm aware of the issue at Schiehallion and the refurbishment, particularly with the ventilation, which necessitated some changes to the water system as well, and

there were ongoing water meetings at that time that I would probably attend and have input to those meetings. We were doing a lot of microbiological sampling at the time, so then we're always looking for a response to the sorts of results that we were getting back.

Q Thank you. Finally, before we move on to your audits, one document that comes up again and again is 2015 DMA Canyon Risk Assessment Report. Are you familiar with that document?

A Sorry?

Q Are you familiar with that document?

A Yes, I am.

Q I think that's question 47, which would be page 9 of the paper copy, 52 of the bundle. You've referred to the 2015 risk assessment being available at the time that you carried out the audit in May 2017.

A Sorry, what question are we looking at?

Q 47.

A Right, okay.

Q So it's the answer there.

A Yes.

Q Were you aware of the 2015 risk assessment at the time that you recommended in 2016 that the audits be carried out?

A Yes. I know it had been risk assessed. I work occasionally with DMA

Canyon Ltd in any case, so I know that a risk assessment had been completed, and part of the audit process is to look at the risk assessment in depth to see that it meets the requirements-- The Health and Safety Executive list a set of elements that should be in a risk assessment, and that's the basis of the question set that is used when you're looking at the risk assessment that's in place.

Q Was the risk assessment part of your thinking in 2016 when you recommended the audit, or were you not aware of it at that time?

A No, I wasn't aware of-- I knew there was an original risk assessment in place; I wasn't sure of what happened thereafter from a risk assessment point of view, and then I found out during the audit process.

Q Well, I'll just ask the question, then, in general terms: was the treatment of that risk assessment a matter of concern to you?

A Can I ask what you mean by "the treatment" of it?

Q When you looked in May 2017----

A Yes.

Q -- bearing in mind what had been recommended in the 2015 risk assessment, was the way that those 2015 recommendations had been

treated-- was that a matter that raised some concern with you?

A Yes.

Q Could you elaborate on that at all, (inaudible)?

A If you take, for example, the 2015 risk assessment-- I'm working from memory here now. In fact, if you'd let me refer to my notes.

Q I think in fairness, actually, it might assist you to go to question 128, which is page 68 of the paper statement, 25, I have-- No, 68 of the bundle, 25 of your paper statement.

A Question 100 and----

Q 128 to 129.

A So the outcome from a risk assessment is generally two-fold. You will get a set of remedial actions based on maybe gaps that the risk assessment or the risk assessor has found. Some of these could be structural with the water system, some of them could be managerial if the paperwork wasn't right, if the training records weren't available, so there's a broad scope of what can be in the remedial actions, so that's one of the outcomes.

The other outcome is you may get advice as to what to do on an ongoing basis to keep the water system as safe, microbiologically, as you can. So that's your two outcomes. When I looked at it-- and I'm looking at my answer here.

There were remedial actions in the risk assessment, but I couldn't see any evidence really that they had been addressed.

Q And is that across the board?

A No, I think I was specifically concerned-- Can you go to the next page, please? (Inaudible). Yes, I mean, there was a risk assessment. We'll look at the water safety plan that's in place in a building and comment on its suitability. There wasn't a water safety plan that I could see at the time, so that was an example. There was other examples in the risk assessment. I think some dead legs were identified. In risk reduction terms, dead legs are the enemy. We try to avoid them at all costs. I couldn't see any evidence that they had been removed or had been addressed.

So, there were a number of things that did stand out from the risk assessment. The data on the management personnel wasn't there, there was also a cold water storage tank on floor 12, which feeds a helipad, and it wasn't in that particular risk assessment, but it may have been excluded from the scope.

Q Thank you. I think, at this point, I can turn to that audit of May 2017. It's bundle 15, page 1042.

A Mm-hmm.

Q I think you might have

answered my first question already, but I wonder again if you could tell us how you go about conducting these audits and, bearing in mind you've done it over a period of some seven years now, things might have changed over that period.

A Okay, so before I go to do an audit, I would ask who I'm going to be working with. I need access to the people that are involved in the day-to-day running of the water systems in the hospital. I would write to those people and say, "I would like to see-- made available during the risk assessment process a copy of the current risk assessment and a copy of the water safety plan and within the water safety plan there's a lot of different elements. So you've got task completion, management structure, lines of communication, training and competency, so all the evidence of all of that to be available to enable me to do the risk assessment process, or to go through the risk assessment process.

The risk assessment itself is based on a series of questions. I then work my way through the questions with the individuals who-- you'll see a note there of the staff that were interviewed, and use their comments and the evidence that they can provide to create the assessment document or the audit documents.

Q And might you do a walk-round as well?

A Most often we do a walk-round but not all the time. It's an audit of the management of the water system rather than the component parts of it, for example.

Q When you're making recommendations or assessing the adequacy of what you see, what you learn about, what are you measuring against?

A So there is a-- There's essentially two main sets of compliance documents. You've got the Health and Safety Executive's documentation, where they have an approved code of practice, which is called L8. Running alongside that, they have a health and safety guide on Legionella and water systems, and that's called the HSG 274.

So that's one set of-- one package of guidelines, and the other package is the SHTM 04-01 guidelines, and they're the main two. There are other ones out there. CIBSE, the Chartered Institute of Building Services Engineers, has guidelines. There's various guidelines out there, and then there's British standards that run alongside that as well.

Q Thank you. Now, the document you've got on screen in front of you is titled, "Legionella Management and Compliance Audit – Domestic Water

Systems."

A Yes.

Q And we see the date there, on the left-hand side, 4 May 2017, and your name and the name of two staff members that you interviewed. We start off, the first box, a site general description, much of which I think you've covered already, and then at the foot of the page there's an executive summary.

A Yes.

Q I'd like to look at some of the things you said in the executive summary. First paragraph:

> "Given the findings of this audit and the gaps in the existing risk reduction systems and processes, in the event of a Legionella-based incident at the hospital, NHS GGC would not be in a strong position with regards to its stance on risk reduction and compliance with existing guidelines."

It may be an obvious question, but how positive or negative is that opening?

A That's negative. What I'm saying there is, if you envisaged a situation where somebody caught Legionnaires' disease, you would be asked to-- there would be maybe an investigation, you would be asked to provide evidence to show that it wasn't you. If you've been doing everything you should be doing, it's unlikely that you caused that issue, and the evidence wasn't there to support that position for Queen Elizabeth.

Q You then go on:

> "The Hospital is now in full use. The current risk assessment was completed over two years ago and prior to the hospital being fully opened. There is therefore a need to complete a new risk assessment, and from that, define the required tasks in a new and updated written scheme."

A Mm-hmm.

Q I wonder, can you explain that paragraph briefly? Is there a particular requirement to have a risk assessment within a particular time?

A The HSE used to require that a risk assessment be reviewed or renewed every two years. They reissued their guidance document in 2012 and that two-yearly requirement was removed from that guidance document. In its place, they said that a risk assessment should be redone or reviewed in the event of significant change to the water systems. Okay? However, the SHTM 04-01 documentation still has the two-yearly requirement, so you have a difference now.

THE CHAIR: Mr Kelly, I think you've answered these questions and it's-- I'm just looking for confirmation.

We're looking at your May 2017 document----

A Yes.

THE CHAIR: -- and as Mr Maciver has just drawn your attention to, you mention the current risk assessment document being more than two years ago. So that takes us back into 2015, and what we're talking about is the DMA Canyon----

A It is.

THE CHAIR: -- report. So, you were at least aware of there having been a risk assessment by DMA Canyon----

A In 2015----

THE CHAIR: -- no later than May of 2017?

A Yes.

THE CHAIR: I think you may have answered this question already: did you actually see the risk?

A Yes.

THE CHAIR: Right, so you----

A At the time of the audit----

THE CHAIR: -- would have seen the DMA Canyon report in May 2017?

A I did.

THE CHAIR: Right. Thank you. As I say, I think you probably said that already----

A No, it's okay.

THE CHAIR: -- but just-- I want to make sure I'm keeping up.

Q Right, so the third and fourth paragraphs, I won't read those out in full, but what's being recorded here is your remarks on what you describe as a "haphazard" recording system.

A Yes.

Q Can you explain that and why that is a particular concern of yours?

A The term I used was "haphazard" because, when I went along to do the audit-- and I had written beforehand an email beforehand saying, "I will require the water safety plan or the written scheme documentation, the evidence of task completion," for example. It could be in paper format. It could be an electronic format. It could be a combination of both.

There were some paper records, not a complete set. They were difficult to find. They weren't-- You know, it wasn't as if they were sitting on a shelf one folder next to the other. I would ask for some information and someone would say, "I think I've got that over here," so it was-- it wasn't a well-controlled environment in terms of documentation at that particular point in time from a water perspective, so that was where-- that's why I used the term haphazard.

The issue with it being haphazard, because there is an issue with that, is that part of what a responsible person should do or an authorised person should do is review the records, look for trends, see if things are going awry and

proactively trying and address them, and if the records were that haphazard, then it was very difficult to do that. Probably impossible to do that. I've got to say, when you look at happens there now, it's superb, but this was my findings at the time in 2017.

Q Okay. We'll get there in due course, but how are the records now? How do they compare?

A The records are excellent now. You know, they're accessible, they're all there, they're up to date. There's virtually no gaps at all, and they're very impressive.

Q You recommend in the fourth paragraph there:

> "As the hospital is extremely large and complex, it may be beneficial, and may also increase efficiency and levels of compliance task completion, if an electronic-based planning, control and recording process for Legionella-based risk reduction processes and procedures was considered."

Is that what you're talking about as being in place now?

A The NHS GGC now has-- I think it's FM First as their (inaudible) system, their computer facilities management system, and that has an electronic element. It produces the tasks which can go to the competent persons to go and complete – "take the temperatures from these outlets" or whatever those tasks might be – and as the tasks are completed, that job, I believe, is closed off in FM First.

There are still some paper elements to it. So, tank inspections, for example, to look inside a tank, to see the condition, may have some photographs which will be stored in a paper record, but they were-- they're readily available now at the drop of a hat, basically. You can go in and look at them at any time. They're managed very, very well by the people who are involved. (Inaudible) Clarkson really manages it extraordinarily well.

Q So, to summarise that last-- your last few answers, haphazardness is a problem of its own?

A Yes, yes.

Q And does it follow from there that that's because, if it's haphazard, you can't easily tell what's been done and what's not been done?

A It's-- I mean, looking for trends is important, so looking to see if the cold water temperature starts to climb in June and July, as we start to get into the summer months, and potentially going above 20 degrees centigrade would present a microbiological opportunity for growth. So, it may be that we increase flushing, for example, at that point in time to pull fresher, colder water into the

system. So that's an example of being proactive by using trend analysis to try and keep the water as safe as possible. And when the records were bitty at best, and not even in the one place, then I can't see how you can do that successfully.

Q Thank you. Moving down a couple of paragraphs, the one that begins, "With regard to competency..." Here you raise that there'd been:

> "... an urgent need for training to be delivered to the Estates' manager who currently appears to hold the responsibility for the delivery of the required processes and procedures."

Firstly, can you recall who that was?

A That was Tommy Romeo.

Q You then go on:

> "There is a lack of clarity in the paper-based system of who is accountable for what and of the competencies of the involved NHS GGC staff and the contractors that are used. It should be pointed out that there is not an authorised person for water in post at the QEUH."

So a number of issues in that paragraph. First is you're concerned about the level of training for a particular individual.

A Yes.

Q The last sentence points out that there isn't an authorised person for water in post at the time that you're doing this audit.

A Mm-hmm.

Q Are the first and third sentences linked? Is it the Estates manager that you're referring to carry-- Is the role that he's carrying out effectively authorised person for water?

A Yes, it would be an AP water that would take on board the day-to-day operation of the risk reduction processes and procedures.

Q Your first sentence suggests that he was not, in fact – and you didn't think he was, in fact – the office holder of authorised person for water. Is that right?

A My understanding, from when I went to site, was that Tommy Romeo was the Estates manager who looked after a lot of elements of the hospital, including the water, the operation of the water systems. A statement was made to me when I was doing the audit that he-- and Tommy made the statement himself-- he'd never been trained, he'd never had any water training, so that raised issues for me in that how can you know the right things to do if you don't know the right things to do, in effect?

And he had not been appointed as the AP water, so there was no AP water, and the person that had the day-to-day responsibility, who should have been the

AP water – may well have been appointed in the future, I don't know – had a lack of training.

Q An authorised person for water is, as his Lordship referred to yourself, in respect of being an authorising engineer. Authorised person for water is a specific office.

A It is. It's identified in part B of the SHTM 04-01 document.

Q Thank you.

THE CHAIR: And again, it's an obligation on the health authority to make the appointment?

A I believe it is, yes. And I check the competency of the individuals that are involved to make sure that they're technically competent. I can't talk about their managerial skills or their, you know, their personality traits, but I look at their technical capabilities in terms of their ability to hold that role.

Q I rather glossed over the middle sentence of that paragraph about there being a lack of clarity in the paper-based system of who's accountable for what.

A Mm-hmm.

Q Is that another aspect of the haphazard recording system that you were referring to earlier?

A Yes. The delivery of risk reduction processes and procedures to a large, complex hospital is really down to

one person or even one group of people, so some of the tasks might be completed by NHS Estates staff, some might be completed by clinical staff. They might be doing the flushing. I've seen examples where domestic cleaning staff are doing the flushing. Some of the tasks will be done by contractors because it's more specialist, like cleaning and disinfecting or descaling of shower heads every quarter, every three months.

So what you do have is a number of people inputting into the delivery of the overall water safety plan. One of the things we look for in the audit is clarity about who is responsible for what so that it avoids finger pointing in the event things get missed.

Q To close off, the big paragraph at the bottom is the summary, where you point out certain aspects that need to be improved. To what extent, in summary, was this a picture of a compliant water system?

A The most I could say is that it was partially compliant. You know, they had a risk assessment in place, but it was out of date. If we use the two-year recommendation, they did have some tasks that were being done. There may even have been tasks that were being completed that weren't being recorded, so they may have been doing more tasks than I could find the evidence for, but at

best, it was partial. I had question marks over the competency of the staff to deliver. I found it strange that somebody that hadn't had any water training was responsible for water system in a hospital of that size.

Q Thank you. If we move on to the next page, and I'm going to take you through the audit, not line by line, you'll be pleased to hear, but I want to look at the general scheme of how you compile a document such as this. At 1044, it starts a list of your comments and recommendations on various aspects----

A Yes.

Q -- of the system that you've inspected, and it goes on for some four or five pages, I think, but they're divided into sections. The first section, comments and recommendations on the risk assessment, and that's specifically, I think, your consideration of what had and hadn't been done with the 2015 DMA Canyon report.

A Yes, and I mean, that's-- I know I've got a storage tank that wasn't in the risk assessment, so that required to have been done. The HSE have a specific list of what a risk assessment document should contain, and the DMA documents are of a very high standard, so they more or less had all of that there.

So, other than the cold water storage tank and comments about renal

dialysis not being included-- but, in fairness to DMA, they say in their document that they didn't do the, you know, their-- the scope of what they did is covered in the document. So you know that. It's not like there's something not been done and you don't know about it. That's a very specialist water system, a renal dialysis water system.

So the risk assessment audited well, I think, is what I'm saying. The standard of the risk assessment was high, but there was some tweaks that were definitely needed.

Q Okay, so there are five separate comments and recommendations on the risk assessment, and then each of the blue boxes is another heading, "Schematic drawings," then (inaudible)----

A And each section is based on a question set for that section.

Q Okay. Well, I'll take you, maybe, to the first of those, then. If we go down a few pages to, I think it'll be 1049, it may be 1048. At 1048, that's the end of the recommendations, so we can see here that among the various sections, we get to 54 recommendations.

A Yes.

Q If we go on to the next page-- in fact, it was at the end, sorry. Back up. The very bottom goes straight on to the first----

A The first section.

Q -- the detailed narrative of risk assessment. So, number one is what you've been speaking about: "Is there a written risk assessment in place for the building water systems?" And then we get your narrative in the right-hand box, which goes on to the next page about describing the 2015 risk assessment. If we go on to the next page, you'll note that your recommendation is that there should be, as a matter of urgency, a new risk assessment completed.

A Yes.

Q That's what you've been telling us about.

A I think it's important to note that the risk assessment was completed in a hospital with no patients in it. So, once patients and staff move in, you start to see the patterns as to how the water system is being used, and it's important that it's assessed to see that the way it's being used isn't increasing risk in any areas.

So there may be examples of cleaner rooms that are just not being used. You know, they're using a room at one end of a corridor but not at the other, and these are the sort of things that you would commonly get from a new and updated assessment on a working building as opposed to an unopened building.

Q In perhaps its most obvious sense, this would be the change of circumstance that you were referring to that should prompt a new risk assessment.

A Yes, on both counts in terms of when-- the recommendations of when you should do a risk assessment – from the HSE's point of view, significant change – and from the SHTM point of view, it was over two years since it had been done in 2015. So, on both counts, it should have been redone.

Q Thank you. So we shan't go through it line by line, but each of these rows is another question and then a narrative of your findings in response to those.

A Yes.

Q Where do the questions come from? Is there a set list, or is this something that you come up with yourself?

A The questions on risk assessment are based on the requirements for what should be in a risk assessment as defined by the Health and Safety Executive, and that list can be found in the HSG 274 document.

Q Thank you. So passing over 2 and 3, if we see box 4 is asking the question of whether the risk assessment addresses all the water systems in the building and are there any defined as

being excluded from the scope, and you then give a fairly long narrative in the right-hand box, but----

A Yes.

Q -- this identifies a number of smaller systems that were included, but do we see the second paragraph is the issue you referred to before, which was that you were concerned about a tank on floor 12?

A Yes.

Q What's the significance in particular of that tank?

A It's difficult to know the significance. My understanding is, and I'm not a fire expert, that the system is tested regularly – I don't know if that's weekly or fortnightly – to make sure that the pumps beside the storage tank, which would pump the water to-- if a helicopter crashed on the roof, for example, and caught fire, so you have to be sure that the pumps work, so it's tested on a very regular basis. If you're testing and pumping water, you could be releasing a lot of aerosol, and if the water in the tank was contaminated or microbiologically active, you could be then spreading organisms around via that aerosol, so that was the concern.

Q So the concern is you're identifying a risk----

A Yes.

Q -- a potential risk that hasn't been taken into account?

A Yes.

Q On the next page, we've got concerns of a different nature at 7 and 8, which are relating to whether the risk assessment contained details of specific persons involved in risk reductions. Then 8 is slightly different: an assessment of competency.

A Yes.

Q And in each case, your narrative indicates that you found the practice wanting.

A Yes.

Q Then, on the next page, we'll see that not all of your narratives are negative because, for example, 16 and 17 are asking about, "Are details of all the component parts included?" and you're happy with that.

A Yes.

Q And 17 is asking about whether sufficient consideration has been given to design flow, temperature and so on. And, again, you're happy with that, so there is a mixed picture, perhaps.

A The risk assessment, as a document, was good. The findings of the risk assessment were the concern, so, you know, dead legs in question 20, their dead legs were noted in section 7 of the risk assessment, for example. So the-- and on the previous page, where there was the responsible person and the

authorised person hadn't yet been appointed, you know-- point to management issues that need to be addressed. So, some of the contents of the risk assessment, while the document was a good document, were concerning, yes.

Q Thank you. The blue box at the bottom of the page is the start for the next heading, so if we go over----

A Yes.

Q -- you see these are the comments and recommendations from the risk assessment, and then on the next page, in the box at the top, we've got five bold headings and I think I'm correct in saying these are the five (inaudible)----

A They're (inaudible) to the front of the document to make it easier to work with for the client, yes.

Q So, that's the scheme of the audit, in effect. You go through it topic by topic or area by area, ask the appropriate questions and boil those down into recommendations or don't, depending upon----

A Yes.

Q -- what answers you come up with. So the next page is schematic drawings, for example, and if we move over to 1053, we'll see that that also results in five comments and recommendations, and then the start of the next section is "Management and competency." Now, that section goes on at greater length.

A Yes.

Q So, for example, question 32 is asking, "Is the duty holder and responsible person nominated in writing?" and your conclusion is that there aren't. Explain the significance of that to you.

A It's-- the duty holder is typically, and is described in the Health and Safety Executive, as the person with overall responsibility for health and safety, so that variable is the Chief Executive. A responsible person would be appointed by the Chief Executive and it's recommended that this is done in writing so that there's no dubiety about whether you are the responsible person or not. So, it's just clarification for both parties – the appointee and the appointer – that the appointment has been made.

Q If you see on the fourth line of your narrative, this section just gives a generic description of the roles and that in itself is a problem, in your view, is that right?

A Sorry?

Q Sorry, that in itself is the problem, in your view?

A Yes, yes.

Q If we go over the page, we've got perhaps a similar box, 33:

"Is there a clearly defined management structure which also

includes relevant on-site personnel and service providers and contractors?”

And you observe, "There's no named management structure available on site. One should be added."

A These should all be-- these are all elements that you would expect to see in the water safety plan or written scheme document, so these would all be elements of that document.

THE CHAIR: Could I just interrupt? Going back to 32, it's just that I'm not sure I understand what you're saying there. We say there's a folder entitled the "Water Safety Logbook." Now, do I understand what you found there was simply descriptions of roles but no allocation of individuals to these roles?

A I'm working on memory now and I've got to be honest, I can't quite remember----

THE CHAIR: Right.

A -- exactly how it was structured. It was quite some time ago, but there was definitely a lack of clarity or I wouldn't have-- about who does what, I think, or I wouldn't have made that statement. That's the best way I think I can put that.

THE CHAIR: Thank you.

Q So, seizing the phrase "lack of clarity," do we again see that as a theme arising through this section?

A Mm-hmm.

Q 33 is about management structure, 34 is about lines of communication. In each case, is your response drawing attention to the lack of clarity?

A (No audible response).

Q At 36, the issue is, I think, slightly different. You’re asked about copies of on-site personnel training records and, in the narrative there, the-- Well, can you explain what you found when you looked at that?

A Yes, there were training records in personnel-- I don't know if it was personnel files, but there was a-- files available with some training records in them, and I made a comment that a collated forum can be useful rather than having to go through multitudinous bundles of paper, which-- and that collated forum now does exist with NHS GGC.

So I looked at the training records of the individuals that I was looking at, Phyllis Urquhart and Tommy Romeo. I know that Phyllis had had water-based training in the past, but Tommy Romeo had none and that's what came out of that, and I made that comment, "The manager has not had any water or Legionella-based training." And, again, I said, "The manager's not an authorised person," so I recommended that training

should be done as soon as possible.

Q Thank you. Again, at 37, we see you being asked, "Do all staff have relevant, up-to-date training in place?" And here, you're observing it's simply not possible to answer that question.

A No, the evidence wasn't there. If I go and do an audit in NHS GGC, now it is there. And this is not just the Estates manager I might be-- it's most often an Estates manager I'll be working with, it's the authorised persons that might be working underneath him and the competent persons below that. The competent persons, typically the technicians, technician-grade maintenance assistance that will go out and complete some of the tasks like taking temperatures and doing regular flushing. So all that information is now available on an electronic system in NHS GGC. There was nothing there that I could find on the day of that audit or the two or three days of that audit.

Q Thank you. At 38, the question will be split over the pages, but the question is, "Is their evidence available in the written scheme of the competency"----

A It's the contractor competency, yes.

Q -- "of service provider and contractor staff." So, in a way, it's a similar point, I think, which is that you

don't know the answer to this.

A I mean, I did know-- DMA Canyon Limited were the main contractor for provision of some of the water hygiene services, and because I know the company, I know their level of competency and it's very good, but there was no evidence anywhere.

DMA include it in their risk assessment document – there'll be documentation on the competence of the risk assessor – but the point I was trying to make here is that if you are using any contractors on site who will come on site and touch the water system in any way, shape or form, they should have at least awareness training to know the implications of what they are working with or what the implications would be of working with a water system.

I think it's important and there's been a big move in the industry to do that now. Contractor competence is very, very important, and Glasgow is very good at that now, NHS Glasgow is very good. They will interview people from time to time, plumbers, and if they haven't had awareness training, they will say, "You can't work here."

Q At the very top of the page, in the narrative box, there's not a formal written scheme available on site. Written scheme has arisen a couple of times.

A The water safety plan, yes.

Q Yes. Is that an issue of its own, a problem of its own, the fact that----

A Yes. So it's-- you're tasked legally, from a Health and Safety Executive point of view, to do two things with water systems. One is you must risk assess them, and the other thing is that you must deliver risk reduction processes and procedures. What those processes and procedures are are contained in that written scheme document or in sometimes called the water safety plan, along with a raft of other information like training records, like competencies, like the definition of who does what, accountabilities-- should all be in this working document, and I couldn't find what I would describe as a formal written scheme at the time.

Q Thank you. If we go over the page, please, I think it's one more page. This section concludes with comments and recommendations. Again, we've got 1 to 9 on this page and then if we go to the next page, it goes up to 11----

A Yes.

Q -- and then the next section is dedicated to the written scheme monitoring and records, and the first question there, at 43, "Is there a written scheme in place?" and, again, you're making the observation that there is not.

A **“**There is no adequate written scheme” is exactly what I've said, which

suggested that there was bits and pieces there, so-- but there wasn't-- I think the word "adequate" there is-- There was not a document there that would usefully help deliver the risk reduction processes and procedures with confidence.

Q The need for a written scheme is important enough that it merits a whole section of your audit.

A Yes, and again, the contents of what should be in written scheme are described by the Health and Safety Executive in a list in that document, HSG 274, so it's-- the questions are based on what's on that list.

Q The very fact that you are asking yourself that question and the answer is, "Nothing adequate of itself" is a significant negative, is that right?

A It is.

Q In fairness, you're saying within this answer at the bullets that there are certain elements available when you look for them.

A Yes.

Q My question, I suppose, is how satisfactory is that arrangement?

A Well, it clearly wasn't enough. One of the elements that is required is a risk assessment, so that was there, and reading my second point there, there's a folder on the Estates office titled, "Water safety logbook." It contains some of the requirements of a written scheme, so

some of the things were there, but you only need to miss one thing and the risk is increased, I suppose, is the best way to think about it. You could do all the temperatures every month that are required, you could clean the shower heads, but if you're not doing the flushing, you know, it's not going to work.

Q And the consequence of there being no written scheme or there being appositive records is that you can't know whether (inaudible)----

A You can't be confident that you're keeping the risk as low as is practically possible.

Q Thank you. If we go over the page, I'm looking for box 47. It's the bottom of this next page. The question here is, "What's the level of completion of the program tasks in the written scheme over the past 12 months?" and do we, again, see here a partial answer?

A Yes, yes.

Q And, again, is the significance the same for that, if the answer is partial, you can't----

A Yes, it's what I was referring to earlier on when I said that there was something that-- when we were talking about haphazard. So, there should be monthly temperature records taken at what we call sentinel outlets and, as I say there, three months in 2016, there are no records. That doesn't mean it wasn't

done, but it does mean we can't evidence that it was done and that's a concern because if the temperature for those three months in the hot water system had been 40 degrees, or in parts of the hot water system, that's a microbiological opportunity again.

Q Thank you. If we go over the page, again, I'm looking down to box 48. Perhaps could we go on to 1063? The bottom-- the second-last bullet there, "Water sample populated sheets folder." You're recording here that:

> "This folder contains record of Legionella samples that have been taken in QEUH. Samples are taken on a monthly basis and not from the same areas each month. The samples are sent to the Alcontrol laboratory at Bellshill. The sample detail form is supplied by Alcontrol.
>
> [But then it states] The form does not state whether samples are taken on a pre-flush or post-flush basis. Samples are taken by NHS Estates' staff. It's not known if these staff have received specific training on how to correctly take Legionella samples. [And then] The results are sent back to the QEUH and are stored electronically."

Q Is this an example of what you're saying whereby there's some records of things happening, but the

records themselves are not good enough for you to take satisfaction about anything?

A With this one, it's specifically talking about Legionella sampling. There's very clearly defined techniques that you must employ when you're taking water samples. It's not just a case of turning a tap on and taking-- putting water in a bottle and sending it to the lab.

I talk there about pre-flush and post-flush samples, and they tell us different things. So a pre-flush sample would tell us if we had Legionella living in the tap because you'd take the water immediately when it comes out of the tap. A post-flush sample is designed to tell us if we have Legionella in it. It will tell us we have problems further back in the system. We have a system issue as opposed to a tap issue.

But there was no indication of what these samples were, whether they were pre-flush or post-flush, and the techniques for taking pre-flush and post-flush are different. They involve disinfecting the tap for the post-flush, removing tap inserts and things like that.

So, my view was at the time that if people hadn't been trained – and it's likely they were not – if samples were being taken and there were some being taken, they weren't being taken correctly. Now, you might still get positives back or non-detectable samples back, but it's open to question if the sampling technique is incorrect.

Q Would you agree with me that this is a particularly significant paragraph here? It's dealing with an important matter, Legionella sampling.

A It's dealing with an important matter and it speaks to the comments made earlier about lack of training as well. I believe, eventually, that sampling was contracted out to DMA Canyon, and they know how to sample perfectly. So it was addressed ultimately by doing that, but it was a concern at the time that we had untrained staff maybe taking samples incorrectly, which could lead to us getting results that were not correct.

Q So this would be an example of the type of scenario you illustrated earlier, where you can do four out of five tasks but fail on the fifth and it invalidates or undermines the legitimacy of the whole process.

A Yes, it's-- and there's also an element of the “haphazard” here. You know, we're taking samples, but when I dig in and have a look, I'm not convinced they've been taken correctly, so that's a concern for me.

Q Thank you. Can we go back to 1064, please, and can we scroll down to box 59? There's one last reference here to the written scheme at 59:

> “Does the written scheme contain an 'audit trail' for out of specification situations which allows for remedial actions to be tracked through to completion?”

Your answer is, "No, this has been commented on earlier."

A Yes.

Q Is it fair to say this be a particularly important box for yourself?

A What you will find when you deliver these risk reduction tasks and processes and procedures is that, from time to time, you will get out-of-specification results, so your temperature might-- should be greater than 55 at a hot outlet, for example, and you get it at 45. What's important then is what do you do about that? And you should record what you do about it through to closing the problem out so that you can evidence you had something out of specification, you defined the remediation, you completed it and, effectively, it was signed off. And I couldn't find that, and that's what we call an audit trail and I couldn't find any evidence of audit trails.

Q Thank you. So, at the bottom of this page, we start the comments and recommendations in the written scheme, and if we go over it runs to – fairly lengthy – it goes to 19 in this page and then I think to 26, ultimately, on page 1067, and we then move on to the “Correct and safe operation” section.

Number 61, I'm interested in: "Is there evidence in the written scheme that any dead legs are removed?" and your answer there, "There's no evidence that any dead legs have been removed from the site," and you make reference to the 2015 DMA Canyon report having identified some dead legs and those being detailed in the recommendations section. Your conclusion here is, I think, that-- must be that you don't know whether any dead leg action had been taken, but it follows, I think, from what you've been telling me in the last few minutes, that that in itself is a problem.

A Yes, having dead legs in your water system effectively means you've got sections of pipework with stagnant water in them. If the water's stagnant, the temperature generally falls into the-- the cold water heats up, potentially, or the hot water cools down, and we always try to avoid water between 20 and 45 degrees because that's the area that's most conducive to bacterial growth or the range that's most conducive to bacterial growth.

Additionally, if we are using chemical disinfectants at any time in the system for either shock disinfection or continual disinfection, which I know you were speaking about this morning, if you have a dead leg, the chemical doesn't get

into the dead leg; it just passes by the end of the pipe and nothing goes in. So you have no-- you lose the chemical attack that you might have on the microbiology in a dead leg and, that being the case, the dead legs then become areas where biofilm can develop quite happily and then leave the dead leg and reseed the system with microbiology, so they're very important.

Q Yes. 64, on the next page, is, I think, perhaps technically separate but effectively the same issue as dead legs: "Are little-used outlets listed and are they then flushed?" And you record here that you don't have-- other than some areas, you don't have any indication as to whether flushing was taking place, but does this again illustrate the problem that you've been telling us about, that if you don't record things, then you can't tell whether they're being done or not?

A The guidance calls for little-used outlets, which is any outlet that's not been used for seven days, effectively, to be flushed twice a week in healthcare – it's once a week outside of healthcare – and it's to do with delivering fresh water to the outlet at the right temperature and, if you're chemically dosing, delivering chemical along with that fresh water, so if it's not happening, while it doesn't constitute a dead leg, you do effectively have stagnation in there, so it's a

microbiological opportunity again.

The big issue with it, and this happens – it's not a Glasgow issue, NHS Glasgow; it's an NHS issue – is who does it, because it can be a huge task and some hospitals use clinicians, some use domestic cleaning staff, some use Estates, some use contractors, but I couldn't tell who was doing anything here, if anybody was doing anything, and that was the big issue.

Q Yes. No, I understand. So, this section concludes at the bottom of the page with three recommendations and a fourth on the next page, and we then have a section on ongoing water treatment, which isn't applicable.

A At that point in time, there was no chlorine dioxide going into the hospital water system.

Q Yes, fair, and then, at the bottom of the page, a section on cleaning and disinfection procedures, which concludes on the next page with three recommendations, and then there's capital projects, which don't apply to us, and effectively that concludes your first audit.

A Yes.

Q These are the, I think as we said, 54 recommendations and this is how you arrive at them. Set list of questions come up with by yourself, and that's the distillation of observations,

things to work on, negative points.

A Yes. I'm sorry, was that a question?

Q It wasn't, but I'm glad that you treated it as one.

A Sorry.

Q I think you answered already my question, but how satisfactory is an audit like this?

A It's not particularly satisfactory. If I did the audit now, it's a totally different document.

Q Well, we'll come on to that, but in May 2017, how concerned did that make you, given that you would be aware that, at that point, the hospital had been open and had patients for some two years?

A I was concerned, very concerned, which is-- because these are strong recommendations. These are not minor recommendations, many of them, and 54 is a large number of recommendations to come out of a hospital audit.

Q Were you able to form a view on how safe the water system was at that time?

A I think the best way I could respond to that was-- The answer is no because I didn't know-- you know, I didn't have microbiological data or anything like that about how the water system was behaving microbiologically, but what I can say is that I was concerned that it could misbehave microbiologically, given the findings of this audit.

Q Is that essentially another aspect of the “haphazard” point that you're making? I just can't tell----

A Yes, I think you could say that, yes. Yes.

Q Right, thank you. Now, I'm going to go to your other audits but hopefully in considerably less detail on them.

A Okay.

Q The first of those-- or the second audit was July 2018. That's bundle 18, volume 2, at page 909. Again, we see the date of it, 23 July 2018, in this case, your name and then there are three other staff interviewed on this occasion. You detail, in the “Date of previous survey” section-- you're detailing a little bit about how-- or when the previous one was and a little bit about your process here, the pre-audit setup meeting. Do you have it on screen in front of you?

A Yes, I do.

Q Yes.

A Yes. Yes, I do.

Q Can you tell us about the pre-audit setup meeting? What did that cover?

A Can I-- Sorry, I didn't hear that clearly.

Q The pre-audit setup meeting

that you describe in the "Date of previous survey" box, what was the purpose of that?

A Again, working in memory, it was just to go through what I would be looking for when I come to do the audit in terms of documentation, the people that might need to be there, so it was agreeing the scope of the audit as described in the paragraph above. So, essentially, it was to try and make, I think-- because I don't normally do that, but I was asked to do it in this instance. It was to try and make the audit itself, the mechanics of the audit, go smoother than possibly the first time we did it.

Q Thank you. On the next page is, I think, the executive summary, and the first paragraph here describes the previous audit and you're noting that:

> "Since that time, there's been a microbiological issue in hot and cold water systems in the children's hospital. That's resulted in a significant level of focus in terms of providing the correct risk deductions, processes and procedures in those properties."

The second paragraph is noting that the updated risk assessment has been delivered----

A Yes.

Q -- and that, presumably, was satisfactory to you, and you record that there in the third paragraph:

> "It's pleasing to note that there have been significant improvements and advances in delivery since the previous audit in 2017."

But then, you note in the fourth paragraph at the bottom of the page:

> "While the improvement is to be commended, there still remain a number of issues that should be addressed. Many of these are required in the task definition and delivery area. As an example, these would include issues such as clearly defining and delivering a little-used outlet flushing regime that meets the requirements of the SHTM and SHG standards."

Now, is that the last issue that we discussed on the previous audit?

A It is, yes.

Q What you're noting here is that it's still an issue today?

A It's still an issue, yes.

Q How much of a concern is that to you, conducting another audit after----

A The flushing is very important. Keeping the water moving is one of the key ways in reducing bacterial opportunity. So, if the water isn't moving, there's increased bacterial opportunity in the water system, and very often-- and, as I said, it's not solely NHS GGC that this is an issue. It's defining who does it

because many people say, "It's not my job to turn a tap on," and it is as simple as turning a tap on and flushing the water out. The NHS guidance asks for it to be done for a period of three minutes. The Health and Safety Executive guide is slightly different.

Q Setting aside the content of it, to you, as auditor or assessor, is it a concern separate, and a concern in its own right, that you've made a series of recommendations in 2017 and when you return a year later to find that precisely the same concerns are in place?

A Yes, it's clearly a concern, and I note where some of the things have been done. I'd guess I need to go through it line by line to see if I've noted that elsewhere, but yes, it's still a concern, yes.

Q If we go over the page, there's what's perhaps a similar issue at the top. Do we see that? There are also a number of higher-level issues – TMT servicing and Legionella sampling – and at least Legionella sampling is something that we discussed maybe 10 minutes ago.

A Yes.

Q So, again, would the same apply that the fact that this recurs is, of itself, a problem for you?

A Yes, if the same thing's occurring, it's obviously a concern. I can't

remember if the sampling had been contracted out – we'd need to look further on in the report if I cover that later on – but yes, it's clearly a concern if it's still there. And as you can see below, this time, Legionella control, we started to colour-code some of the recommendations.

Q Rather than using up time going through the audit line by line, I wanted to concentrate a little bit more on the scheme of this, but we've got colour coding, which is presumably for ease of reference.

A It's to try and make it-- the urgent requirements jump out rather than having to read it all.

Q Okay, so if we scroll down, we can look for those. So, if we go down to the next page, we see the summary of recommendations start here. Now, it's got a bright blue box and then kind of greenish-blue boxes indicating where these recommendations come from. So, this time, we've got-- rather than five recommendations from the risk assessment section, we've got one.

A One, yes.

Q Does it follow from that that that's an improvement over----

A Yes, it is.

Q Yes. Then, schematic drawings, we have two on this page, and then, over the next page--

A Yes.

Q So we got two for schematic drawings. For "Management and competency," if we scroll down, we have-- This goes on, but we have nothing red yet. "Written scheme," if we go down that.

It's only now on page 916 that we start to get to the red recommendations. If we go over the next four pages, we see there's a concentration of red here in "Management," and then at 920 we've got more red in the "Correct and safe operations" section. Then, I think over the page there's more red in "Ongoing work"-- no, there isn't. "Water treatment" is yellow.

So, if we can go back up to 916 and just to the first of the red boxes, please. We've got 14-- is relating to shower and hose cleaning and descaling, and ensure that appropriate records are kept in the logbook. Now, your narrative here is fairly short, being done on retained estates only. Does that indicate----

A No, that's-- Those comments are not my comments. Those comments are the NHS comments.

Q Right.

A They're not my comments.

Q Okay, so----

A So this copy that you've got is not the original. It's one that the NHS have commented on.

Q I understand, so this is-- that column exists to-- basically as a check that your recommendations have been carried out or that are still ongoing or whatever the case might be.

A Yes.

Q Thank you. Now, if we look at the nature of the-- The fact that these are red boxes in the audit indicates that, in July 2018, these were matters of urgent concern to you.

A Yes. The way we characterised the recommendations was that, if a recommendation was required to-- or if there was an opportunity for bacterial growth and dissemination by maybe a failure in the delivery of tasks here, for example, then that should be a red and should be addressed quickly. Some of the records were missing again. When I look at what drove that particular comment and with records missing, then I can't be confident that the task had been completed.

Q So boxes 15 and 16 here are in the nature of records being missing?

A Yes, yes.

Q 14 is a particular task that isn't being done?

A Yes. Every three months, you are meant to clean and descale and-- well, and they disinfect generally at the same time the shower head and hose, and that's a lot of showers in the Queen

Elizabeth.

Q Yes. So, can we go on, page by page, please? 917. Box 17, again, is about recording, issues around the recording of hot and cold temperatures, and 18, again, is also about temperature recording, is that right?

A In my comment on that, there should have been 12 monthly sets of temperatures because this is monthly requirement and there were actually 12, but there were-- some of the temperatures were recorded coming out of a thermostatic mixing valve and they're 41 degrees, so they're not representative of what the hot water system's doing.

Q Is that what prompts the comment at the end of your box 18, that appropriate staff are required to be trained in how to take and record the temperatures?

A Yes.

Q We shan't go through this box by box, but if we go down to the end of the recommendations – I'm afraid I don't know what page that will be, but it's to number 35 – we will see that the scheme is similar to the last audit in that we then move on to the actual questions you're asked and then your----

A Yes.

Q Is this your narrative in the comments box this time?

A Sorry, could you say that again?

Q Where there's a risk assessment and there's a question, this is your question?

A Yes, that's my narrative, yes.

Q And the comments are your narrative?

A Yes. Yes, it is.

Q So that's how we should interpret this report?

A Yes.

Q Thank you. For reasons of time, I'm not going to go through these individually. I'm not going to attempt to, but in general, to summarise, would it be fair to say that, in some areas when you're doing the 2018 audit, you're recording an improvement, but in other areas you're recording things that you've recommended but that haven't happened?

A Oh, there had unquestionably been an improvement, and when I look at the people that were involved in the audit, they had put a lot of time and effort into bringing the thing up to a far better standard. The bulk of the reds tend to be around task completion and the ability to find records to say that things had been completed, but there was no question that there had been an improvement. I mean, there are 20 less recommendations to start with, roughly.

Q Yes. Can we go on to 934,

please? I'm cherry picking here, but there is-- Can we go on to the previous page, please, or can we go up until we see what the question was? "Is the level of completion of the programmed tasks in the written scheme over the past 12 months suitable?" on page 9-- at the bottom of page 932. And then, because there's so much in your narrative here, it goes over a number of pages.

A Right.

Q The one I'm interested in is 934, and it's to the box marked, "TMVs/TMTs servicing" at the top. Just for completeness, what are TMVs and TMTs?

A Thermostatic mixing valves and thermostatic mixing taps, so these are the scald-prevention devices. They're obviously running hot water at 55 plus, which will scald – first-degree burn in a matter of minutes – and the TMVs and the TMTs mix hot and cold water to a preset temperature, which is normally 41 degrees, so it's a scald-prevention device, but they require servicing.

My findings at that time, reading it, is that it was happening in the high-risk areas only, so that would ICU, neonatal ICU, perhaps renal dialysis, those kind of areas. "TMTs in other areas do not appear to have been serviced" was my comment, so that was the concern.

Q So there's a mix of-- and perhaps we see this even more clearly in the showers section halfway down the page, where you're record:

> "There is a need to ensure that all records are signed and dated. There is some data covering shower cleaning and disinfections but there are various shower cleaning records missing."

And you give examples of that. So here, you are recording a mixture of things not done and things not recorded.

A Yes.

Q Is that similar to what you found in the 2017 audit?

A Yes, it is. There was definitely more records available to help me identify the gaps, if you like, than there was in the previous audit. So there were-- If you look at the showers one, for example, there were records for shower cleaning, which did have some gaps, whereas before, I can't be sure there were records for shower cleaning. I need to look back, but there were more records available in a much less haphazardous way. In fact, they weren't in a haphazardous way.

Q Okay, well, I think that really gets to the nub of my point about this 2018 audit, which was-- It follows from what you're saying, I think, that you've seen an improvement from 2017 to 2018?

A Yes.

Q How satisfactory would you say the system was in July 2018, when you did the second audit?

A It still was providing microbiological opportunity, perhaps less than 2017, and certainly the people that were involved with it, from a competency point of view, were better than the people I'd seen-- well, one particular individual I'd seen in 2017, but it was still a concern. There were still concerns there.

Q Thank you. I don't think I'll take you to any more on the second audit, but I'm going to briefly look at the other ones. The January 2020 audit is bundle 18, volume 2, page 1355. We know the format by now: first couple of pages are description of the dates, your involvement, description of the site. 1357, two pages further on, we get the executive summary, I think.

THE CHAIR: Is this Bundle 18?

Q 18, volume 2.

THE CHAIR: Thank you.

Q It's a fairly lengthy executive summary here. I shan't ask you to read it, but, in general, would you agree with me that here you're very focused again on the record-keeping?

A Yes. Yes, it's a key part of the risk reduction process, and the stance that I tend to take is that if there are no records there, there's a chance that the tasks were not completed.

Q If we look at the bullet at the bottom and then perhaps over to the next stage, we see a number of references to where records might be inadequate to do with temperature. Then, on the next page----

A I mean, it's-- If you go back to the previous page and look at the first one on there, there was only five records of temperatures being taken, and when temperature is your primary means of control, that's concerning.

Q Well, that's what I was going to ask then. Given this is your third audit----

A Yes.

Q -- and it's now maybe some three years after you've started to raise issues such as this, how concerned are you in July 2020 to see something like this?

A I'm still concerned that about-- particularly around task completion, that there's-- the hospital water systems are not operating at the lowest possible risk level or certainly there's-- it's a struggle to evidence that they're operating at the lowest possible risk level.

Q Thank you. If we go on to the next page, the other bullets relate to matters such as plant room checks, addressing faults, including specification results, remedial tasks, dead legs and so on. The fact that these are on your bullet list, do these indicate these are your

primary concerns?

A Yes. Yes, they would be.

THE CHAIR: Can I just ask your help on a question of terminology? Am I right in thinking that a sentinel tap is there for the express purpose of taking a sample?

A No, it's----

THE CHAIR: Well, help me, then.

A Sentinel taps are defined typically as the nearest and furthest tap from a cold water storage tank, for example, or the nearest and furthest hot water tap to the calorifier or the plate heat exchanger. It's not just two taps in the entire hospital; it would be the nearest and furthest tap on every leg of the water system, so if there's 10 floors and 10 different legs, then you would have at least 10 sets of sentinel taps.

The classic definition is the nearest and furthest tap to either the cold water storage tank or a hot water calorifier, and they're just normal operating taps. They just happen to be----

THE CHAIR: Right, so they're taps that are there for a function?

A Yes.

THE CHAIR: But, beforehand they have been specifically identified as the nearest and furthest on every floor of both the cold and hot water system?

A Yes. On every leg because on some floors you may have more than one

leg of a water system as well.

THE CHAIR: Right.

A So that's the kind of classic definition.

THE CHAIR: Thank you.

Q If we move on to the next page – page after that, please – we see the same colour-graded scheme. In this case, we've got three red entries which are going to fall on the risk assessment's written scheme and ongoing water treatment heads. And if we go over to the next page, I think the recommendations start, so we can quite easily see what the red----

A The red one there was that parts 2, 3 and 7 of the risk assessment weren't available when I did the audit, but I know that they subsequently were delivered by DMA. They had gone missing in the ether somewhere. I don't know whether they'd been sent to someone, but they were. I didn't know that on the day, hence the red colour, but they were there.

Q Does that, then, colour how red this red box should be?

A I can't remember what parts 2, 3 and 7 are in the DMA risk assessment, but I guess they were covering some fairly important points or I wouldn't have coloured them red. It's not just the fact that they were missing, but I do know that they were produced. By this time, GGC

was using-- as you can see there, I said, "Uploaded to Smartsheet." This was an electronic system which stored data and those-- these three bits were uploaded to it after the audit went back.

Q Okay, so is that partially, in fact, reflecting something you've said years before about an electronic system----

A Yes.

Q -- would be useful?

A Yes.

Q So perhaps we might mentally colour that a little less bright red, then?

A Sorry?

Q We might mentally consider that to be a little less bright of a red than we've got here.

A Yes, yes. Yes, yes.

Q Right, can we go down to the next red box, please, which is again a series of reds relating to recommendations from the written scheme? The number 13 is about reviewing dead legs again.

A Yes.

Q Can you recall your concern there?

A It's just that they couldn't tell me the status of the dead leg removal programme, so were dead legs being removed or were they not, and if they were, could you show me that they had been taken out? And it just left it grey. It

was a kind of grey and woolly thing and because it's dead legs, then it is very risky.

Q Okay, but that's something that we've seen before?

A Yes.

Q So, presumably, that's prompting concerns, is that correct, from you to see this (inaudible)----

A It is, but dead legs-- it's not like the hospital is built and there are (inaudible) 20 dead legs in it and then once they're all gone, they're all gone. There'll be changes in the way the water system is used, equipment might be moved, sinks might be taken out and dead legs can be created as well in the ongoing process.

Q Perhaps, then, we draw a distinction between the dead legs themselves and the recording of them?

A Yes, but there were definitely dead legs identified in the first risk assessment.

Q Yes, but the fact that you're in 2020 still having to make recommendations that, for example, the status of dead leg removal be reviewed or recorded----

A It may be a recording issue, but it may be a non-removable issue. I just couldn't tell which.

Q Even if it's just a recording issue, that's still----

A Yes.

Q We've covered already that that's a concern-- separate concern for you. My point or my question, really, is to what extent is that ringing an alarm bell, the fact that this is the third time now that you've had to raise this?

A It rings an alarm bell from the point of view of my inability to be completely confident that all the dead legs were gone.

Q Okay. We can read, I suppose, these recommendations for ourselves, but is it fair the remaining red ones here are, again, largely about recording things?

A Yes, so there was-- I'd need to look at the next task, the task completion element.

Q Can we go over the next page, please? Just for completeness, we've got a sea of red on this page.

A Yes.

Q And again, it's reviewing recording, ensuring the tasks are completed, is that right?

A Yes, it's task completion again, yes.

Q It's the same problem over and over again, that----

A It is.

Q -- you've asked for recording or you've recommended that recording be done, and when you come back it might

have improved but not to the extent that it's going to make you happy.

A Correct, yes.

Q And if we keep going down to the end of the recordings list, we see that we're at 43 this time, which I think is-- All right, that's gone back up.

A It's gone back up, yes.

Q Does it follow from the fact that there are more recommendations that-- Does that make this a worse audit, or is it not as simple as that?

A No, I think a lot of the things had been addressed bar that task recording situation, so I wouldn't like to say it was necessarily worse. I think the best thing I could say is it was-- it might not necessarily have been better, but I don't think it was particularly worse, but I'm working on memory now and I don't think it'd be right just to look at the number of recommendations and say, "If it's higher, it's worse."

Q No, that's fair. Well, maybe I'll ask-- just ask your memory of your own recollection, then. Given this was your third audit and you're still having a considerable – I think you'd accept – number of recommendations, were you having concerns at this point as to whether your audits, your task, your work was being effective?

A I wasn't at the point in time, but I can see the reason why you're asking

the question. What we do now in Glasgow is when the audits go back in, we then have follow-up meetings. We have a standard operating procedure where we have follow-up meetings and go through it line by line with the relevant Estates manager and the compliance manager, but that didn't happen back in 2020.

Q Now, that, in a way, anticipates what my next question was going to be, which is-- I was going to ask whether there had been a process available to you if you did-- if you were concerned, to raise such concerns.

A I mean, I raised the concerns in the report, basically.

Q With anyone else, is what I mean.

A No, there wasn't a process to raise them with anyone else. I didn't send them further up the line, for example. I had my contact that I worked with, or my point of contact that I would work with, but other than that, I didn't do anything other with the reports. The report became the property of the NHS for them to use, but that was kind of it, really.

Q Okay. Well, lest I inadvertently mischaracterise what you just told me a moment ago, the follow-up meetings that you're describing now, are these also internal or are they-- These are following up with the people that you've done the audit for, is that correct?

A Yes, so if we pick a hospital like Glasgow Royal Infirmary, I would do the site visit, the audit report within usually about a month. We would then convene a meeting with the Estates manager that I work with at the hospital, who will be a senior manager, and usually a compliance manager is involved and we go through the recommendations line by line and update the status of them. Many of them will have been done because we see far fewer recommendations now.

Q Okay. Well, on that note, the February 2021 audit, the fourth one is at page-- I think we're still on bundle 18, volume 2, so it's page 1402 of this bundle. Again, the format is the same, so we start with the site description and then, in the next page, the executive summary. Still site description, so the executive summary must be the next page. Here, in the first paragraph, you are describing that it was:

> "… previously a lengthy and time-consuming process. However, much improved record systems and updated processes that have been developed and successfully implemented have made this a less onerous process."

A Yes.

Q It records problems in January 2020 of finding records and evidencing procedures being completed, but that's a matter that has been-- At the time of this audit in February 2021, is that a matter that's largely been addressed?

A Yes, a lot of the things had been addressed. The format of this audit was slightly different. It was split into document A and document B, and the reason for that was that the management review-- because the people involved here managed the whole site, so the management review covers the whole site, so we did it separately because we were going to do audits of the task completion per hospital building. So, rather than repeat the same thing time after time after time, we split it into document A and document B. So the document B element will be specific to the Queen Elizabeth and, yes, a lot more had been-- was being done.

Q Okay. I think I may only have document A and any questions for you are on that, but just to keep it brief, at page 1407 to 1408, we see now that we are into a shorter – onto the next page – a shorter list of recommendations.

A Yes.

Q Fourteen, and they're mostly yellow, with some orange.

A Yes.

Q Presumably that's----

A Much better.

Q -- unambiguously an improvement.

A Yes.

Q I'll just put a few questions to you on the content. At page 1411, at the bottom here, you're dealing with dead legs again.

A Yes.

Q Dead legs, specifically detailed in the risk assessment, and the answer, essentially, is yes. Is that right?

A It was asking if dead legs were specifically identified in a risk assessment. It's one of the requirements of a risk assessment to identify if there were dead legs there, and the risk assessment did identify if there were dead legs. I can't remember if it identified they were there or there were none, but it was identified it had been addressed in the risk assessment document.

Q Yes. If you remember that, mentally, I was dividing the question, too, last time. Quite apart from the substance of whether dead legs were a problem per se, the issue of recording was a separate problem?

A It is a separate problem.

Q Is this-- that problem has now been addressed?

A This is referring to the risk assessment, so this is saying the risk assessment addressed the dead legs. I

don't know if there's anything in the next page about it, possibly not.

Q Look over the page, please.

A No, there's not, so I can't say from what I've got there whether there was dead legs identified in the risk assessment. It says:

> "The information on dead legs can be found in Section 2: Recommendations of the risk assessment document."

If there are recommendations regarding risk assessments, that suggests there were still some dead legs there.

Q Okay, well, perhaps I can't take that any further. There's limited use in doing so, but, in essence, this is a much-improved position----

A Yes.

Q -- not only from the first audit that you did but, in fact, from the previous audit, there's been a significant improvement since----

A Without question.

Q Just for completeness, then, the fifth audit should be at page 1335 and, again, the format is the same. We start with the details of the date and the interviewers and then the site description, and then the page after that is executive summary. Again, we repeat the positive vibes----

A Yes.

Q -- from the last one. If we look at 1339, we see a list of summary of actions, and this is recording. We're now down to 10 and they're all yellow.

A And a lot of them are paperwork related, really, rather than whether tasks were being done or not done.

Q So, at this point, how satisfied are you with your work?

A That's a pretty good audit in a hospital, particularly one of the complexity of the Queen Elizabeth and the RHC.

Q The sixth audit is from January 2023. It's in a different bundle. It's bundle 15, page 2026. Again, the format is the same. If we can look at, on the next page, the executive summary here, there's a couple of points I'd like to be clarified. At the start, you say the-- you refer to the previous audit, March 2022. That's the one we've just looked at. I called it the February----

A Yes.

Q -- 2022 audit. I think it was the cusp of the two months, so that would be the same document, is that right?

A (No audible response).

Q On the fourth line, you're saying:

> "The current audit yielded nine recommendations and that's favourably compared to last year's

audit review which had 23 recommendations."

Now we just looked at-- I think was it 10?

A Yes, that was 10 in that one section.

Q That was part A rather than part B.

A Yes.

Q If we'd gone to part B, we'd have seen another 13.

A Yes.

Q But in any event, this year we're down to nine.

A Yes.

Q And you go on to explain that there are two new high-risk recommendations, and they're about the provision of a new in-date risk assessment.

A Just trying to find that.

Q That's on the fifth line there, yes.

A Yes, to-- Yes, yes.

Q But when it comes to addressing last year's audits:

"The recommendations have been virtually addressed and it's pleasing to note the recommendations from the extant risk assessment had been completed."

But you're now recommending that we get a new one.

A Yes.

Q Can we go down to the lists of reds, really? The first two I think will be about the risk assessment on the next page, 1229. So, 1 and 2 are what you've just told us about updating the risk assessment. Number 8 is different in nature, though, and you're recommending here that:

"… until the expansion vessels are converted to flow through that a flushing programme is initiated as soon as possible."

A Yes.

Q Can you explain your concern there to me, please? It may be, in fact, that this isn't new here and it's perhaps it was in part B that I didn't take you to before, but the specific concern about expansion vessels----

A Expansion vessels are used in water systems to take out pressure fluctuations so that when pumps come on to pump water around the hospital and you open a tap, there's a pressure surge and the water can bounce out the tap and spit out of the tap, and you put the expansion vessels in to take these fluctuations out of the water system.

The standard design is what we call a single point of entry. They're just connected onto the pipework running to the taps, usually back in the plant room, and a single point of entry when,

effectively, it's a built-in dead leg. So, I think they've all been converted to flow-throughs now in the hospital, with the exception of the accumulators. Flow-throughs, we actually take the water and pass it through the vessel, so it never has any dead leg area in it.

So, my concern there must have been that they were in the expansion-- they were, yes, that's coming back to me now. They were in the process of converting all the expansion vessels, and if there were any that hadn't been converted, a flushing programme should be initiated on them.

Q Right, so that's the last of your red recommendations in January 2023, and then, for completeness, January 2024 is your most recent audit, so that's at bundle 27, 27.1, I think. Page 252. If we go down to the recommendations at page 255, we see we're now down to seven recommendations, and if we look at the red one there, it is the same----

A Yes.

Q -- flushing vessel-- expansion vessels point that's been taken over.

A And that's a very low number of recommendations for a major hospital.

Q So, therefore, my question is perhaps obvious, but to what extent are you satisfied with what you've seen over these seven years?

A The way the water system is being managed now, you know, if I had to go into that hospital, I wouldn't worry about the water, put it that way, I suppose is one way of putting it. It's a well-managed water system now, but it's a-- Water systems are extraordinarily dynamic, so things are changing all the time, but there are systems in place to oversee all of that.

Q So, in terms of satisfying the public in terms of what risk might be posed by the water system, firstly, what would your view be on that? And secondly, what would the basis be for you giving that degree of reassurance?

A When I do the audits, obviously I'm finding very few things that require attention. Additionally, I know that at the hospital there's still lot of point-of-use filters on the final tap outlets so that even if there was the likelihood of bacterial development in the water system, the point-of-use filters would prevent the bacteria from getting to the patient.

So, in one hand, the water systems have been operated far-- in a much better way, and on the other hand, you have that catch-all at the end of the lines where it's important, where we-- particularly with immunocompromised patients, that we have a final barrier to bacterial release as well. So, from my point of view, it's a safe water system right now.

Q Thank you. Well, I've not got any more questions for you on the audits. I do have a couple of catch-all questions at the end, but, typically, we have a short gap before I put those to allow-- to canvas views whether there should be anything else raised.

A Okay.

THE CHAIR: Before we take a break-- because, as Mr Maciver says, I'd like to find out from the room whether there are any additional questions, but on point-of-use filters, is your understanding that the Queen Elizabeth intends to retain point-of-use filters, at least in areas where there are more vulnerable patients?

A I'm not aware. I know we are in discussion about that and they asked for my input on that discussion, but I'm not aware of the final outcome. I think the discussions are in progress and I don't think a decision has been made on that basis yet.

THE CHAIR: Do you have an opinion on the desirability or otherwise of using point-of-use filters in the longer term?

A I do. While point-of-use filters are a final barrier to bacterial release, they also slow the water flow down overall, so you have a balance of risk situation now where, by preventing final bacterial release, you are possibly

providing enhanced opportunity for bacterial growth in the system.

My view is – and I'm already seeing this in other countries – that in high-risk areas-- Filters are used as the norm in places, in certain hospitals in Germany, I believe, and possibly some other countries in mainland Europe.

Where we've got a well-managed, well-working water system with no microbiological evidence that anything is going wrong, there's no need for them, in my opinion. Certainly any areas where there are patients that are immunocompromised. Where you have low-risk patients, my view would be that if we can take them off, we should take them off, but we have to do that in an evidence-based approach.

THE CHAIR: Right, but the only downside, as it were, that you identify is that because they impede water flow slightly----

A Yes.

THE CHAIR: -- that will have that-- (inaudible)----

A A backup feed.

Q A backup?

A Yes, and I listened a bit to Tom's stuff this morning. He spoke a lot about biofilm, and it's about, you know, increasing the opportunity for biofilm development, which we try to avoid as much as we possibly can.

THE CHAIR: Well, as I said, Mr Kelly, we'll take a brief break, and I would hope you would be concluded in the not-too-distant future.

A Thank you.

THE CHAIR: You'll be taken to the witness room.

A Thank you.

(Short break)

THE CHAIR: Mr Maciver?

Q I do have a number of additional questions now, maybe around 10 minutes or so.

THE CHAIR: Very well. Mr Kelly, we have a few more questions.

A That's fine.

THE CHAIR: Mr Maciver.

Q I will just ask them one after the other. They don't follow into any particular section. First question is-- if you could have a look at page 60 of the statement bundle, please, and your answer to question number 91. You were asked about disadvantages of using chlorine – that should be chlorine dioxide – and you mention an effect on pipework and water. Can you explain your concerns, please?

A Chlorine dioxide is what we call an oxidising biocide. It's quite an aggressive chemical. It's actually a gas in solution. You have to make it in situ; you can't buy it in a drum. You have to mix chemicals to make it, and it's injected into the water. It's a gas. Well, it's created in the water, but it's technically a gas in solution and it could be very corrosive, not at the use levels that we use it at, which is a maximum of 0.5 ppm.

The comment I was making there is that, over time, it would have an effect, as chlorine would, as peroxide would. They're all aggressive chemicals. To quantify it, maybe the best way to think about it would be if the lifetime of the pipework was 50 years, if you're using chlorine dioxide, it might come down to 45. You know, it might-- I have no data to support that, but that's the kind of way I think of it in my mind. So, it will have an effect, but it would be a slow effect over a long period of time, generally, but if it's overdosed, it can degrade component parts of water systems.

Q Yes. I think, in fairness, you clearly state you're not a metallurgist, but you do indicate some materials that you consider to be effective.

A It can be aggressive, too, and has been aggressive, because I've seen it, I've installed it and I've worked on the supply side many times to some plastic components. Certain plastics embrittle and fail with it, but that's not the case at the QE. That's not been an issue there.

Q Okay, thank you. My second

question is about something we've mentioned already, the Schiehallion unit, and you said that you weren't aware of the actions that might have been taken before re-entry into that unit after the refurbishment. My question, really, is that, I understand it reopened in March 2022. When you were carrying out your audits either side of that, did you give any special focus to that unit?

A No. When I said I wasn't aware, I was in the water technical group and I was in the water safety group for the Queen Elizabeth, so it was discussed at length in those areas in terms of, "What do we need to do to be comfortable that it was safe to reopen the unit?"

The answer I gave earlier was, "Was I aware of what was happening in the unit?" That's how I thought you were asking, what was happening physically in the unit. So I did have input and I was involved in some of those discussions, but I-- and there was additional sampling done, for example, when that was happening, but other than that, I wasn't asked to have any other focus on the unit other than take part in the technical discussions around reopening.

Q Thank you. Third question is to do with the closing of your evidence. Before you mentioned that, I asked about whether you had concerns about the

water system now and you said something like, "If you were a patient now, you wouldn't be concerned" entering back in. What about if you were a bone marrow patient, would your answer change?

A I think the way-- the best way I could answer that was if I was a-- because I've got a biological background, I understand a little bit about it and worked with infection control doctors a lot. If I had a bone marrow transplant, I would-- or if I had bone marrow issues, I would be concerned about any infection at all because you have to be, and where we have bone marrow transplant units, we very often spend additional time and resource on the water. So, if I was a BMT patient, yes, I would have, but it's not because of it's that hospital, it's just in general, I would have.

Q Nothing specific to Queen Elizabeth?

A I don't think so. The water that is now in play at the Queen Elizabeth is very well run. The temperatures are the primary means of control and they are generally very good. It's backed up by chlorine dioxide, so you have a fallback even if temperatures slip out of specification, and you have point-of-use filtration on many of the outlets, particularly in areas where there are susceptible patients. It's possibly as safe

as you can get it in a current standard hospital today.

Q This may be reading in too much to your remark, but if you-- given that you said you wouldn't be concerned if you were a patient today going in, if you were a patient a few years ago, would you have been concerned?

A Knowing what I know now?

Q Yes.

A If I was a BMT patient, yes. If I was a standard patient, and I think Tom just talked about that-- There are many microorganisms out there and we're exposed to them on a day and daily basis and they have no impact on us at all. That's very different for a BMT patient, so-- as I understand it, so yes, I probably would have, knowing what I know now.

Q Given that you've been doing audits over a period of seven years, are you able to pinpoint a date when that changed, an inflection point?

A I think the most-- When the management improved, I began to feel a lot more comfortable about the water, and certainly when chlorine dioxide went in, that builds that extra layer of comfort that the water system, even if it does go out of specification-- from a temperature point of view, chlorine dioxide is a great assistance in keeping the risk low. Even when you consider things like dead legs that might still be there, some of them we

might not even know about, if they release microorganisms into the water from the dead leg, there's chlorine dioxide there to aggressively attack that.

Q I was perhaps unfair in my wording of the questions. I asked you to pinpoint a date when things might have changed. That was suggesting very specific, but you've given me the answer there, based largely around chlorine dioxide, so does that suggest that an inflection point might have been around 2019, when that----

A If that's when it went in, yes, yes. I can't remember the exact dates, I'm sorry to say, when everything was installed.

Q The next question I've got is about point-of-use filters, where you'd indicated to his Lordship just before you went out that, ideally, they would not be in place. I think that was what you said.

A Ideally, they would not be in place where there was low-risk patients.

Q That's what I was going to ask you: how would your answer change with respect to high-risk patients?

A There's definitely a movement towards using point-of-use filters as the norm. It's being heavily discussed now. Even if everything is fine with the water system and all the boxes are being ticked, it gives you that final barrier to microbiological release. So, where

patients are particularly susceptible, there's discussion about whether-- should we just have them as the norm in those situations now?

Q Your view on that would be what?

A My personal view?

Q Yes.

A I would use them in those situations.

Q Right----

A But I'm not clinical, remember, you know? So, that's a personal view from a water guy rather than a clinician.

Q No, that's fair. I appreciate that. A few more questions. The first of them is in relation to-- going back to something we discussed at the very beginning and about your position as authorising engineer to the health board rather than to particular hospitals as such.

If you're an authorising engineer to Greater Glasgow and Clyde in-- I forget the exact dates, but 2011 onwards, I think it was, and Queen Elizabeth opened in 2015 and your first audit was 2017, how satisfactory is it that the scenario arose whereby the board did have an authorising engineer but that he wasn't doing audit work on Queen Elizabeth Hospital?

A I think the way I would respond to that would be that GGC had an asset

that they could have used but they didn't, in that-- and I'm not making myself out to be a particular expert of-- but, you know, I'm a well-experienced water hygiene individual that could have perhaps been used but wasn't, but I guess that's a question for GGC and not for me.

Q Perhaps the question I would ask you is whether that was good enough in that situation?

A If there's an asset there that could be used to help and wasn't used, it could have been done better. I'm struggling to give you a very direct answer to that because it's-- obviously, with the power of hindsight-- and you can't push your way in and demand work, you know, you do it on request. But with hindsight, yes, it could have improved things.

Q Well, that was going to be exactly my question to you. One of the first things you said to me was that you didn't want to be talking your own book. I'm not sure if that's the right phrase, but you know what I mean, pushing yourself forward where you didn't necessarily need to be, and I also asked you about the advantages or otherwise of having an independent person as opposed to a board employee, for example, as an authorising engineer, and you explained that in terms of marking one's own homework.

Might it be the case that, in actual fact, one of the advantages of not having independent people in the role is in terms of accountability, in terms of an employed authorising engineer might have more locus to see work not being done and to demand that it be done?

A I can see that, yes.

THE CHAIR: Sorry, could you just give me-- I'm not quite sure I followed the question. I mean, obviously, Mr Kelly understood you. Could you just repeat that question?

Q I certainly couldn't verbatim, my Lord. I was drawing a link between a number of threads in the evidence, which was firstly whether or not it was advantageous to be an independent practitioner rather than an employee who was carrying out the auditing function, and Mr Kelly explained earlier on that independence carries benefits in terms of not marking one's own homework.

My suggestion was whether non-independence, i.e. being accountable within the board structure, might carry an advantage in terms of seeing lacunae in work being done, work not being done in terms of auditing a particular hospital and being in a position to make demands, suggestions, pull strings in order to have that work done in a way that an independent practitioner might not be. That was my suggestion to Mr Kelly.

THE CHAIR: It's not my role to be the witness, but can I just tease this out and I'll be corrected by Mr Kelly if I'm wrong: Mr Kelly has indicated that the role of authorising engineer is to be found, defined, in SHTM 04-01. Now, also in SHTM 04-01, there are another-- there are a number of other rules. Mr Kelly has mentioned the authorised person, the responsible person and I think there's also a designated person.

A There is, yes.

THE CHAIR: Now, I at least throw out for your consideration that one might find-- Oh, I should add this: am I right in thinking that the authorising engineer is defined in SHTM 04 as an "independent"?

A Yes, I believe it is.

THE CHAIR: Yes, so the authorising engineer has to be independent, although I appreciate you're asking about the auditing function.

A Yes.

THE CHAIR: But can I at least throw out the possibility that one finds in the designated person, responsible person and the authorised person internal, or the potential for internal responsibility?

Q Yes. In that case, my question-- I maybe----

THE CHAIR: However, maybe this is a matter for later consideration.

Q No, the-- It may be, but there's a follow-up question that occurs to me, which is, in retrospect, having-- (To the witness) Were there strings that you feel that you could or should have pulled earlier than you did in order to get the audit carried out?

A No, I don't think so. The report goes in to the person who can make the things happen on the hospital. Whether they share it further up the line or not, it's out of my control, quite frankly, but I don't think there were strings I could pull without it becoming a horribly political situation, perhaps.

Q Thank you. Just a couple of questions to go. We looked at the audits: 2017, 2018 and 2020. There was no 2019 audit. Can you explain that gap?

A It was just a gap. Again, I was doing them by request, and I never got a request to do it, but eventually within discussion, we realised it had slipped. It was no more than that.

Q I suppose, again, in retrospect, ought you to have----

A Yes, it should have been done.

Q -- given someone a prod?

A As close to 12 months as it should have been done-- as it could be done, yes.

Q Thank you. The next question is just a clarification on a point that we may have covered, but are you able to

give any clarification on when you did see the 2015 DMA Canyon report? It wasn't perhaps clear whether it was around the end of 2016 when you recommended an audit or in 2017 when you were carrying out the audit.

A It's-- and I'm working purely on memory now.

Q Yes.

A And, working on memory, I can't remember exactly when. All I can say is it is most likely that the first time I saw it would be when I was doing the audit.

Q The last question that I have is a specific one on a specific issue of the taps. We discussed, I think, or we may not have done, but the question is, in terms of maintenance of the taps, are you currently satisfied that the taps in QEH are being maintained and cleaned in accordance with manufacturers' instructions?

A We were talking about thermostatic mixing taps.

Q We were.

A Yes, and my understanding is that they are being serviced by DMA Canyon Limited. I haven't looked at what they deliver compared to what the manufacturers recommend, but they are definitely being serviced. The service protocols are pretty standard in terms of stripped down and there's a failsafe test

that you have to do, temperatures of water in, temperature of water out. There's a few things that have to be done, strainers are removed and cleaned. So, as far as I'm aware, that is all being done, yes.

Q Just for completeness, if that's in relation to those specific types of taps, are there other types of taps that you are aware of-- whether they have been maintained according to manufacturers' instructions?

A Yes. The thermostatic control is mostly delivered through thermostatically controlled taps at the Queen Elizabeth. There are some thermostatic valves that are not in a tap, but they sit as a separate-- I'm sure there are some of those in the hospital, but they are serviced in the same way. A thermostatic valve is remote from the tap and it delivers water at 41 degrees to a standard hot tap.

There are different manufacturers of thermostatic taps, so there are different ways of opening them up, taking the component parts out and servicing them, the strainers in different locations, but the general principle is to tick the same boxes. In terms of the actual tasks, they might just have to be done slightly differently with different manufacturers' taps.

THE CHAIR: Just thinking about what you've already explained to us, are there taps in the hospital that are not thermostatic taps?

A Thermostatic taps? I think there may be, but I can't be 100 per cent sure.

THE CHAIR: All right.

A I would be surprised if there weren't.

THE CHAIR: Right.

A But I don't want to mislead the Inquiry, so, if there are any, they will have a separate mixing valve.

THE CHAIR: Yes.

A One of the benefits of having it in the tap is that, if it's not in the tap, it would be a valve that would be behind a panel, for example, and to get to it you have to take the panel off and that's an infection risk in itself with----

THE CHAIR: Yes.

A So, having it in the tap reduces that infection risk when you're servicing.

THE CHAIR: Again, just to check that I'm following, when you explained that the purpose of a thermal mixing tap----

A Yes.

THE CHAIR: -- either the thermal mixing goes on the tap or immediately before the tap-- is to prevent scalding.

A Yes.

THE CHAIR: So I assume that all taps that were-- Well, I assume from that

that perhaps all taps were thermal mixing taps, but there is the possibility of taps not being thermal mixing taps?

A Yes, there will definitely be-- There are definitely taps that do not have a thermostatic element to them.

THE CHAIR: Right, right.

A Cleaners taps, for example, where you want hot, you know. Kitchen taps where you want hotter water, perhaps. So they are not thermostatically controlled, but there'll be a sign saying, "Caution, scald risk," perhaps.

THE CHAIR: Right.

Q That was the last of my additional questions, my Lord.

THE CHAIR: Right, thank you very much. Just really one point of detail arising out of Mr Maciver's questions: as I understand it, or if I have understood your evidence, you were appointed as an authorising engineer, initially at least, in respect of the whole health board?

A Of the board, yes.

THE CHAIR: Right, okay. The reason I press it is this: I think, as I read SHTM 04-01, it seems to envisage an authorising engineer for a healthcare facility. Is that your understanding?

A All the appointments I have in Scotland are for the boards, and I think once you're appointed by the board, you're available to be used in any and all, if necessary, of the board's facilities. I 've

never seen it that-- or I've never had it that way in my mind. You're making me think about it now, but I've always seen it as a board appointment.

THE CHAIR: Right.

A I think that is the same for (inaudible), the other-- the ventilation, the medical gas, the other ones.

THE CHAIR: I mean, I can see that, if you're a board-wide appointment, that might mean you are the authorised engineer----

A I'm-- Yes.

THE CHAIR: -- for every----

A For the board.

THE CHAIR: Yes, every healthcare facility.

A I get calls for technical support from guys, "Oh, you're the AE, can you help me with this?" You know, it's--

THE CHAIR: Okay. Mr Kelly, thank you very much. Thank you for coming. Thank you for sitting with us a bit longer than you possibly expected, and thank you very much for all the preparatory work that has gone behind your evidence. You're now free to go. Thank you.

A Thank you very much.

(<u>The witness withdrew</u>)

THE CHAIR: Can I take the opportunity to say that I do not propose to sit on Thursday afternoon? That may

have been informally advised, but I would envisage finishing before lunch on Thursday of just this week. Thank you, and if I can wish everyone a good afternoon.

(Session ends)

17:02