SCOTTISH HOSPITALS INQUIRY

Hearings Commencing
9 May 2022

Day 2
Tuesday 10 May 2022
Andrew Poplett

CONTENTS

10:00

THE CHAIR: Good morning. Mr MacGregor, we are ready to begin with your witness for today?

MR MACGREGOR: Yes, my Lord. The next witness is Mr Andrew Poplett.

THE CHAIR: Good morning, Mr Poplett. As you appreciate, I am very shortly going to ask Mr MacGregor to ask you questions. Before then, will you take the affirmation?

Mr Andrew Poplett

Affirmed

THE CHAIR: Thank you very much, Mr Poplett. We will be sitting from about ten to one, but we will probably take a break at about half-past-eleven or so. If, on the other hand, at any time you want to take a break during your evidence, just let me know and we can take a break. But I now invite Mr MacGregor to begin the questioning.

Questioned by Mr MacGregor

Q Are you Andrew Peter Seymour Poplett?

A Yes, I am.

Q And you have provided a witness statement to the Inquiry dated 13 April 2022, is that correct?

A Yes, that is.

Q That is found at pages 97 to 139 of bundle 6 and the Appendix at pages 141 to 143. Am I right in thinking that that statement addresses Health Technical Memorandums that apply in England and Wales and associated guidance?

A Yes.

Q Together with setting out your knowledge of design, installation, commissioning and the validation of ventilation systems in hospitals?

A Yes.

Q The content of your statement will form part of your evidence to the Inquiry. You are also going to be asked some questions today. If you do want to refer to your statement at any point, please do just let me know. Mr Poplett, if I can begin with your qualifications and experience, are you an engineer?

A Yes, I am.

Q And are you an incorporated engineer registered with the Engineering Council?

A Yes, I am.

Q An associate member of the Chartered Institute of Building Service Engineers?

A Yes.

Q And you are also an affiliate member of the Institute of Fire Engineering.

A Correct.

Q If I can ask you just to look within your statement at Appendix 1, so that is in page 141 of bundle 6. You can see at the top, “Resume of Andrew Poplett”.

A Yes.

Q And we see a summary of your employment history. So you trained and qualified as a mechanical building services engineer, and then you have set out your employment from September 1985 to September 1991 with Haden Young Limited. Can you just explain what were you doing at your time with Haden Young?

A I was principally employed as a building services engineer and throughout my apprenticeship I was cycled through the various departments within the company of design, estimation, planning and installation supervision.

Q What types of projects were you working on?

A A whole range from industrial, commercial and some healthcare.

Q Then, in 1992, you moved to Newcastle General Hospital, is that right?

A Yes.

Q Then, for that period, essentially from 1992 until 2010, were you working for various NHS trusts?

A Yes.

Q Could you just explain to the Inquiry what did your work within those trusts involve?

A At different times throughout that period, I was initially recruited as what was then known as a works officer. Very shortly after I joined, it became an estates officer. I had responsibility for specialist engineering services, predominantly ventilation, as well as legionella control within the Newcastle General Hospital. Through various mergers and NHS developments, I rose to the level of assistant head of estates and, for a brief period, acting head of estates before leaving that trust to join another trust, the Northgate and Prudhoe Trust, as head of estates where----

Q If I can just be clear, whenever you are saying that you acted as an “estates officer”, what is an estates officer doing within a trust?

A An estates officer is an operational manager who looks after and runs estates issues on behalf of a hospital.

Q You mentioned ventilation, but is that a wider remit than just ventilation?

A Yeah, estates officers will cover all aspects of both building and engineering disciplines.

Q You mentioned that eventually you became head of estates for one of the trusts. How does that role of head of estates differ from simply being an estates officer within a trust?

A As an estates officer, you are directly involved in the day-to-day management of, in my case, mechanical engineering services. As a head of estates, you are, if you like, one tier up and looking after other operational estates staff under your management or the delivery of the estates service.

Q You mentioned that you were really looking after engineering and, in some aspects, ventilation. At a practical level, what does that involve?

A That's a very wide question. It can be as simple as ensuring that maintenance activities are undertaken appropriately and completed, up to design reviews or involvement in the development of new projects, through to the supervision of those projects and commissioning, and indeed the decommissioning and closing of systems down. In my particular case, one of the largest single schemes I was involved with at Newcastle was that the trust had one of two national centres for bone marrow transplant or SCIDs babies,

babies born with no immune system. Ventilation systems within that facility play a key role in keeping those patients safe, and I was involved from its construction as the client supervisor through to its operation for the next seven years.

Q If I can just ask you a few questions in relation to that: you mentioned that in your role you could be involved in design issues, is that correct?

A Yes.

Q So can you just explain what you mean by being involved in the design stages of a ventilation system?

A Generally speaking, if it is a large, complex design, there will be specialist design consultants and engineers engaged within the project. An operational or project estates officer will monitor that design. They will review it to an extent without taking design liability for it. In a more basic approach, if someone puts a new toilet facility in and it needs extraction installed, the project officer would not normally get a designer involved in that level of project and would design a system that was compliant and suitable.

Q So am I correct in thinking from what you have said that

the client, so the NHS trust, the estates officer would have direct input to an external design team? Is that correct?

A Normally, yes.

Q Can you just explain to the Inquiry what level of involvement the estates officer would have?

A It very much is governed by the nature of the project and the level of input that any individual has or experience they have. So it's more clearly clarified now in the role of what is termed an “authorised person”.

Q We will come on to discuss some of those technical terms in due course, but at the minute you mentioned in your roles as estate officer and head of estate that you would be involved in design. You also mentioned that you would be involved at the construction stage of a ventilation system, is that correct?

A Supervision or observation of installation, yeah.

Q It is obviously obvious to you, but what do you mean by that observation or supervision?

A Site inspections, make sure that what was designed and drawn is actually what's being installed.

Q You mentioned you had also been involved in maintenance issues. What type of maintenance are we talking about if you are either the estates officer or the head of estates?

A As an estates officer, you would look at what levels of maintenance were appropriate for the installation. You would make sure that suitably competent individuals were assigned to complete that maintenance. If there were breakdowns or reactive works, then you may be asked to come in to do investigation or fault-finding works in support of the competent persons, and you would make sure that the maintenance got delivered. As a head of estates, you have a wider or broader remit to make sure that all of the relevant maintenance for all of the different engineering disciplines gets delivered.

Q Again, I will come on to discuss this in greater detail, but you mentioned the term being “involved in commissioning”. Can you just explain in very basic terms what you mean by commissioning in the context of a ventilation system?

A Commissioning is a process whereby you balance the system to make sure that the correct distribution of air is achieved through all of the outlets or inlets that have been delivered and designed, and you

make sure that everything functions properly and appropriately. So things like fire dampers are functional and operational, fans are in balance, they're drawing the right voltage, the airflows are correct and they are appropriately, proportionately balanced. After commissioning then comes the stage of validation, which is ensuring that all of the different engineering disciplines that interact with one another all work as they should.

Q Again, would it be an estates officer or head of estates that has some form of role in that process?

A During my time, bearing in mind we are talking 15 years ago, yes. Today, it would be an authorised person.

Q So if I can return to your CV, please – so that is page 142 of bundle 6 – you mention there that from May 2009 onwards, you have now set up as a company called Andrew Poplett Enterprises Ltd. Is that correct?

A Correct.

Q So what are you doing in this role in Andrew Poplett Enterprises Ltd?

A Providing independent healthcare estates advice.

Q What do you mean by

that term, "independent healthcare estates advice"?

A It very much depends upon the client and what they are looking for. Generally, it has developed into acting as an authorising engineer for both specialist ventilation and water or multiple NHS trusts and some EFI private healthcare providers.

Q We will come on to discuss what that term, "authorising engineer", means but, apart from the aspects of your work that involve being an authorising engineer, what other tasks do you undertake?

A In the early days of the company, I provided general advice and experience on running and setting up hospitals or healthcare facilities.

Q Would you do anything else within your role within the company?

A No.

Q If I could ask you just to have your actual statement in front of you and to look to paragraph 3 on page 98, please.

A Paragraph 3 on page?

Q Paragraph 3, and in the top right-hand corner, it should say page 98.

A I think that's a printed copy, so, forgive me. But, yes,

paragraph 3, “Within this role”.

Q Thank you. Yes, “Within this role,” and if we can look down, perhaps two-thirds of the way down, you will see a sentence beginning, “I now provide independent, impartial and bespoke consultancy services.” Do you see that?

A Yes.

Q You say, “I now provide independent, impartial and bespoke consultancy services such as system auditing.” What do you mean by system auditing?

A System auditing is a primary role of an AE to ensure that the management systems for the control of ventilation are being appropriately provided.

Q When you say “AE”, you mean?

A Authorising engineer.

Q Turning to paragraph 3, there is then a reference to “personnel assessments and awareness training”. What does that involve?

A Before an individual can be appointed as an AP, authorised person, they need to be assessed or their competency established by an independent party, that being the authorising engineer. So I undertake assessments of individuals who want to be considered, either by themselves

or by the organisation, as an authorised person and assess their competence.

Q You continue saying that you conduct “compliance reviews and action planning”. What does that involve?

A It’s part, again, of the auditing process. Having identified where there may be a non-compliance or a shortfall, I provide advice or recommendations as to how that should be addressed and the manner and timescale in which it should be addressed.

Q You continue in your statement saying that you “guide clients through the maze of NHS, HSE guidelines, legislation and compliance”. So is this a highly technical area?

A It certainly can be, yes.

Q And what advice would you be giving to the NHS?

A It very much depends upon the circumstance for which I've been asked to advise or be retained. As an authorising engineer, I would advise on all aspects associated with either ventilation or water with any given site.

Q So, within your self-employed role that you have told us about, how frequently are you utilising

guidelines, legislation, etc., existing within the ventilation area?

A Daily.

Q Just to be clear, what subjects in particular is it that you are advising clients on?

A Specialist ventilation and water.

Q So you have used the term a number of times, “authorising engineer”. Is that a technical term within the industry that you work in?

A It is a term defined within HTM 00 Core Standard as an independent advisor for organisations to provide specialist advice.

Q So, in practical terms, what would you be doing as an authorising engineer?

A I would be undertaking compliance audits, assessing individuals for certain posts – principally authorised persons – and advising the trust or client on design reviews, either at concept stage of design or reviewing designs once completed.

Q Approximately, how many NHS bodies are you acting as authorised engineer for currently?

A It varies over time. At present, I would estimate that it's around 30 to 35 trusts.

Q Thank you. Within your

statement, you mention that you are registered with a body called the Institute of Health Estates and Engineering Management. That is at paragraph 4. Is that often used with the acronym IHEEM?

A It is.

Q So what is IHEEM?

A IHEEM is a professional body similar to the Chartered Institute of Building Services Engineers, which covers building services generally. IHEEM is specific for healthcare.

Q You also mention that you are a founder member of a body called the Specialist Ventilation in Healthcare Society, is that correct?

A Correct.

Q So what is the Society?

A The Society is basically open to anybody within the ventilation engineering field to share, experience, best practice and, at times, develop supplementary guidance notes. It was founded by Malcolm Thomas, who's the lead principal author of the last three iterations of HTM, as a-- it's an unfortunate term, but talking shop to discuss and debate issues that we come across and areas that need clarification or supplementary guidance.

Q So it was formed by Malcolm Thomas and effectively a

forum so that individuals working in this area can meet and discuss issues relevant to best practice?

A Yes.

Q Just to be absolutely clear on your expertise and the assistance that you can provide the Inquiry with: you have obviously outlined within your statement areas of expertise in relation to the design, commissioning and maintenance of ventilation systems, but you have also mentioned various legislation and legal principles at points in your statement. Am I right in thinking, though, that you are not a lawyer and, within that, you are not seeking to give any form of expert legal opinion?

A Definitely not.

Q So should these really be viewed as observations to assist the Inquiry? So, for example, when you made reference to legislation such as the Health and Social Care Act, if I was to ask you to outline specific sections that vouch various propositions, would you be able to do that?

A No.

Q Where does your understanding of that legislation come from?

A From 35 years' experience of dealing with it.

Q And are various points of legislation mentioned within the technical guidance that you will work with?

A At times, yes.

Q If I could move on then and just ask you some questions about general principles of ventilation to try and really focus on those within a hospital environment, what is ventilation at its most basic level?

A The provision of air, in its very basic form, intended to either dilute contamination generated within the space, provide a suitable, safe and comfortable environment, for undertaking an activity that's being proposed within that space.

Q Why is that important in a hospital?

A Within a hospital setting, ventilation in some areas can play a role in minimising the risks or reducing the risks of cross-contamination or infection.

Q You mentioned "some areas" there in your answer. Is it fair to say that some areas are more important than others in a hospital?

A In terms of clinical outcomes, yes, but it very much depends upon how the space is used as to its criticality in terms of ventilation requirements.

Q What do you mean by "it depends how the space is used"?

A For example, an office space that isn't a patient area, isn't being used for any clinical activity, still needs to maintain compliance to building regulation requirements, still needs to provide a comfortable environment for staff to do their job, but it will not have a direct impact on patient outcome. If you have an operating theatre that is inadequately ventilated, you will increase risk of infection as a result of that lack of ventilation.

Q What are the potential consequences for some of those areas of getting into the ventilation system?

A Again, it's driven by the criticality of the patient group. In extreme circumstances, it can lead to very severe consequences up to and including fatality of patient. In less serious environments, it may lead to uncomfortable working conditions.

Q If I could ask you a bit about both natural ventilation and then mechanical ventilation: the Inquiry has heard evidence in relation to both of those concepts already, but what is your understanding of natural ventilation?

A Natural ventilation is a means of providing ventilation without

the use of an external mechanical device. Now, it can be, in its simplest form, an openable window or it can be an engineered solution relying on the stack effect or Bernoulli effect of vertical air ducts and drawing of air across to stimulate either convection or forced air from a natural source.

Q When we are talking about natural ventilation, at its most basic level, it would be opening a window?

A Yes.

Q But there could be more complex natural ventilation solutions?

A Yes.

Q Can you have natural ventilation in areas of a hospital?

A Yes.

Q If I could just ask you to look at your statement again, paragraph 25 on page 108.

A Yes.

Q The second line down, second sentence. So paragraph 25, page 108, second sentence, you say, "In certain circumstances natural ventilation may be the best option." Do you see that?

A Yes.

Q In what circumstances could natural ventilation potentially be the best option in a hospital?

A Natural ventilation is,

generally speaking, the most energy efficient and therefore cheapest to run. However, it can also be affected by a myriad of issues and climate conditions, internal temperatures, external conditions, locations of windows, size of opening, all of which can have an impact on its predictability of performance. So where it is a low-risk area – an office, again, as the example – it may be perfectly acceptable to provide ventilation by means of openable windows. However, where you have areas where you want certainty of performance, you would generally utilise either forced or mixed-mode ventilation to deliver that.

Q You mentioned the term "mixed-mode". What do you mean by mixed-mode?

A Mixed-mode is a combination of both natural and forced ventilation.

Q You indicated that you would want mechanical ventilation if you needed certainty of performance. So can you assist the Inquiry, in terms of areas of a hospital that you would need certainty of performance, what are you talking about?

A Any area where ventilation performance is critical. The obvious, most frequent ones are

operating theatres, isolation suites, where you are trying to either protect an individual from the general atmosphere or protect the general environment from a patient, i.e. infectious or neutropenic, but also where ventilation is critical to equipment performance. So certain imaging areas, CT scanners, MRI scanners, gamma cameras et al., all can require specific environmental conditions for optimum performance. We also use ventilation in terms of controlling exposure limits of workers and indeed patients to potentially harmful substances where local exhaust ventilation comes into effect.

Q Am I right in thinking from your evidence that there are areas where you could quite safely use natural ventilation and there are areas where you would clearly need to use mechanical ventilation?

A Yes.

Q Are there grey areas in the middle?

A Almost certainly.

Q Could you give the Inquiry any examples of such grey areas?

A One of the difficulties with any healthcare design is that it is designed for one function and, invariably, clinical practice changes

over time. When clinical practice or clinical usage changes, that can have an implication on the ventilation requirements. So an area that was originally designed to be naturally ventilated would then not be suitable for natural ventilation and indeed vice versa.

Q So if I could now ask you about mechanical ventilation, what do you mean by the term “mechanical ventilation”?

A Mechanical ventilation is the term used for delivering a forced or ventilation solution, so a given volume of air into given areas for the purposes of either contamination dilution, fresh air provision or isolating aero-microbiologically one space from another.

Q In terms of the system, how are you forcing the air?

A Normally, through either a fan or what is called an air handling unit.

Q Another term that has cropped up during the course of the Inquiry is the term “specialised ventilation systems”. Is that a term you are familiar with?

A Yeah.

Q What is a specialised ventilation system?

A A specialised ventilation

system I would define as a ventilation system which is critical to the effective operation of a given area.

Q Can you give some examples of situations where specialised ventilation would be required?

A Operating theatres, isolating suites, down to hydrotherapy pools or indeed LEV systems, so safety or fume cabinets, autopsy dissection tables, woodworking machinery within the Estates department. There's a whole host of areas where it would apply.

Q I have got you noted as having mentioned one issue being the dilution of contaminants in relation to mechanical or specialised ventilation systems. Is that correct?

A Correct.

Q Can you just explain what do you mean by that term, dilution of contaminant?

A Either through the process that is being undertaken or by the very presence of individuals within a space, every human being sheds skin scales, bacteria constantly. Within this room, currently, everybody is giving off skin scales. Those skin scales can carry bacteria and, in some cases, virus; and whilst they are perfectly safe under normal

circumstances, if you have, for example, a patient on an operating table, you do not want to introduce that contamination to the wound site. The more people that are in a space, the higher the potential aero-microbiological load is, and therefore the greater the need for effective dilution.

Q In terms of dilution, can that be more significant for some patients in a hospital than others?

A Certainly.

Q Could you give any examples?

A The most obvious would be that if a patient has a weakened immune system, either as a result of disease or by a result of treatment, and are more susceptible or vulnerable to airborne contamination, then it is more important to keep those areas well ventilated and well diluted to maintain patient safety.

Q So important in relation to immunocompromised patients. Have you come across the term "neutropenic patients" before?

A I have.

Q What does that mean?

A Neutropenic is basically the extreme end of immunosuppression. If a patient is immunosuppressed, they may have a

weakened immune system, but it still is there in some degree or shape. Full neutropenic patients effectively have no immune system is my understanding as an engineer. I am not a microbiologist and would never claim to be.

Q As an engineer, why do you understand that dilution of contaminant might be important for neutropenic patients?

A Because the introduction of those contaminants can cause infection to those patients.

Q Can ventilation systems also assist in isolating spaces?

A Yes.

Q Can you just explain what you mean by isolating a space?

A If you have a patient who is infectious, then it is essential that that infection doesn't spread beyond that patient or as far as is reasonably practicable. To that end, we use ventilation as one of the control measures to limit the airflow of any airborne microbiology from that patient to surrounding areas.

Q Just in terms of those airborne issues that you were discussing there, if I can ask you to look at paragraph 14 of your statement, please, at page 104. Paragraph 14, page 104, three lines

down in the second sentence, do you see a sentence beginning: "Contaminants basically fall into three broad categories…"?

A Yep.

Q Paragraph 14, page 104: "Contaminants basically fall into three broad categories of airborne risk, these are viruses, bacteria and fungal spores." Again, as an engineer, what's your understanding of those concepts: viruses, bacteria, fungal spores?

A Viruses tend to be extremely small particles. They generally live for relatively short periods of life outside of a host. One obvious exception is COVID. However, they are generally very small, live for short periods of time, and generally still travel within a particle drop-- water droplet nuclei or water droplet to transmit airborne from one patient to another, or indeed from a patient to a staff member. Bacteria are, again, equally very small. Particles can live all over the body in different areas. When they are in the areas where they do no harm, they are not a problem. However, they can travel outside of the body, normally on skin scales-- is the area for airborne infection through bacteria or indeed airborne to hard surface and then contact transmission – but again, generally very small particles, relatively short lived outside of the human body. Fungal spores, when we're talking about airborne particles, are relatively large; we are still talking between one and three microns in size. To put that in context, a human hair is between 70 and 100 microns in diameter, but fungal spores can live for very much extended periods of time and can travel very large distances once released from their source, and again can cause infection.

Q As you've explained, one aspect of ventilation is trying to seek to dilute those contaminants.

A Yes.

Q Can I ask you to look on within your statement to paragraph 20, please, on page 106? You say there at paragraph 20:

> "My reminder for this is the phrase 'the solution to pollution is dilution', with the aim to make sure that there is dilution of any contaminant that's developed within the space to a safe level…"

What do you mean by the term "a safe level"?

A It's very difficult to quantify to a specific number, as it were. There are, within chemicals and certain other airborne contamination, agreed levels or work exposure limits

for some issues, governed through the Health and Safety at Work Act, the Health and Safety Guidance 258, and scheduled on Health and Safety Document EH40, which defines safe exposure limits for contamination. However, there is also the issue of unregulated activity – coronavirus, for example, does not appear within EH40 currently – where ventilation is there to minimise the levels, not necessarily eliminate the levels.

Q So you mentioned health and safety legislation, that's one aspect of reducing things to a safe level, but we'll come on and talk about a whole range of guidance that exists in relation to ventilation systems in hospitals. How would that guidance link into that phrase you've used, "a safe level"?

A The legislation requires organisations to do everything that is reasonably practicable to maintain a safe working environment. So that's where it would come to that ventilation plays a key role in maintaining that safe environment.

Q In terms of maintaining that safe environment, the Inquiry's heard already evidence in relation to a whole raft of things that a ventilation system can do; so one is "air changes per hour", is that a concept you're

familiar with?

A Yep.

Q So can you just explain to the Inquiry what's meant by air changes per hour?

A Air changes per hour is the number of or the volume of air present within a room and the number of times that that whole room volume is changed. It is, however, not as straightforward or as simple as that because it requires whole-room dilution, so the air must be appropriately distributed throughout the space to ensure that the total volume of air is effectively replaced by each air change. The rule of thumb that is utilised is that, for every air change within a room, 63 per cent of any residual airborne contamination is removed providing that no additional contamination is released, and that the room has effective whole-room air scrubbing.

Q So just so that I'm understanding that, you said, as a rule of thumb, every air change is going to reduce matters by 63 per cent. So, if we calculate that on-- say for example there was four air changes, how much would that be reducing the contaminant by?

A Now you're asking me to do maths which is-- I would need a

pen and paper for, but basically it's 63-- The first air change removes 63 per cent; the second air change would remove 63 per cent of the remaining 37 per cent. So, by the time you get to – and the number I do know off the top of my head – six air changes removes 99.8 per cent of any residual airborne contamination. Individual air-change rates and cleaning rates I would need a calculator to calculate.

Q So six air changes takes you to?

A Effectively close to 100 per cent clear.

Q You've given us the formula that we can do the maths ourselves, but it's 63 per cent and then that repeats and repeats, and so----

A Provided no additional contamination is released.

Q Another concept that the Inquiry's heard about is flow rate. Are you familiar with the concept of flow rates? Can you explain what's meant by a flow rate?

A Flow rate is generally either taken in metres cubed per second, which gives a volume flow rate, or metres per second, which is a velocity flow rate. You can also measure it in litres per second should you wish. Rather than using cubic metres, you can use litres. It is a

expression of the amount of air that is transmitted through either a given duct-- at a known cross-sectional duct, gives-- at a velocity, gives you a volume flow rate, or indeed a volume flow rate from a grills you can use to then calculate if there are six grilles and they are all doing one cubic meter a second, the room is subject to six cubic meters a second of supply ventilation.

Q Are they both ways of measuring how you'd be diluting contaminant within a space?

A You can't calculate air change rates or air changes per hour without the volume flow rate because it's the volume of flow rate plus or against the size of the room gives you a number of air changes per hour.

Q You need to know the flow rate and then you can work out the air changes per hour?

A Correct.

Q The Inquiry's also heard evidence in relation to pressure differentials that you can have within various parts of a hospital: positive, negative, or balanced. Can you just explain your understanding of positive pressure and why you might want that in a space in a hospital?

A Positive pressure is when an area, typically a room or suite

of rooms, is kept at a higher pressure or pressure differential to the surrounding areas. The most typical area where this would be used would be for a neutropenic patient isolation facility where you want to filter the air coming into the room at a given volume and maintain that clean room/clean air environment as far as practically possible whilst the room is in use. So the pressure cascade – you'd keep it at a positive pressure so you wouldn't get leakage from surrounding areas into the room, and when doors are used to get in and out, the airflow path remains from the protected area or clean room to the surrounding area, be that a lobby or a corridor.

Q For an isolation facility, you need that to have positive pressure; and you mentioned that that would then mean that that space would be what you called a clean space.

A Yes.

Q Again, can you assist the Inquiry with this concept of moving from sort of clean air to dirty a space? What do you mean by that?

A The principles of healthcare ventilation is that you always want the air to move from clean to less clean. We tend to shy away from the term "dirty" until it gets into a dirty utility where we accept that things are dirty, but generally we are interested in air paths that flow from clean to less clean.

Q So then in terms of the converse of that, if we think about a negative pressure, why would you want that in a hospital?

A In the simplest example, if you have a WC, you do not want any odours or malodorous activity being transmitted out into the surrounding space, so it's under extract ventilation only and that keeps it under a negative pressure differential to surrounding areas which gives no escape of odours. The more health-specific environment would be a protected patient environment for an infectious patient where you do not want the contagious infection getting out of the room so the room would be kept under negative pressure to surrounding areas for the same basic principles as you would do odour control in a WC – obviously the consequences are potentially more serious.

Q Then the final concept would be balanced pressure. Why would you want that in areas of a hospital?

A Balanced pressure is generally where neither is of particular

importance or where you need to try to contain an area but you cannot have it-- you want both, you want it to be both positive and negative, balanced is an option. Most relevant example I can think of is probably an infectious disease theatre. Within an operating theatre, you want a positive pressure and air to flow from the wound site, from the point where the patient is being operated on, outside to surrounding areas – clean to less clean. However, if that patient has an airborne infectious disease, you do not want to be pumping that contamination out into the surrounding areas; but equally, that patient is undergoing a surgical procedure, so you don't want contamination from potentially outside the area coming in to affect the patient, therefore, a balanced pressure theatre would be the approach that you would take.

Q In your evidence, you mentioned the rule of thumb, 63 per cent reduction for each air change; where does that come from?

A My understanding was it was established as part of the original Lidwell report and investigations into healthcare ventilation within operating theatres.

Q So whenever you talk about the Lidwell report, are we talking about a Dr Lidwell?

A Yes.

Q And what report did Dr Lidwell write?

A He wrote a report in 1972 or '74, I always get those two mixed up, that basically looked at and did research onto infection-- post-operative infection rates within patients at different ventilation, and the role that ventilation plays in those infection rates. His research is the basis for the minimum ventilation rates that are still used today.

Q Just to be clear, what's your understanding of the conclusions reached by Dr Lidwell in his report?

A My understanding is that the report demonstrated that around 16 to 17 air changes per hour saw a improvement in infection rates if spaces were ventilated at or above that level.

Q Although that research was focused on operating theatres, are the principles applied more widely?

A Yes.

Q Has that approach essentially become standard practice?

A That is my understanding, yes.

Q Is that research still effectively being used and applied today?

A Yes.

Q Now, we'll come on and look at this in more detail, but you'll be familiar within Health Technical Memorandum that there's tables of air change rates for various spaces. Are you aware of how those tables have been produced?

A Not specifically, no.

Q You have discussed the concept of diluting contaminants. Would it also be possible within a hospital to treat such areas by filtration?

A Yes.

Q What would that involve?

A Filtration is a means primarily of removing particulates from the air. It can be as simple as filtering the air coming in from outside to a given standard, to filtering air leaving a space to remove particulates. You can also filter through not-physical filtration, chemical reaction, certain odours and gases, although generally they are only applied in highly specialised areas of healthcare. Generally speaking, filtration for the majority of areas is today governed by the specific outdoor or external air quality of a given geographic location and the desired internal air quality required to safely operate specific healthcare activities. That then gives

you a filtration grade that needs to be applied to achieve that level of performance. You generally filter initially to protect the equipment used to move the air, or it is a coarse prefilter that filters air through the unit and maintains longevity and efficacy of the plant, through to final filtration that is designed to provide the right environmental conditions or internal air quality for the clinical environment.

Q So, when we're talking about filtration, it can be used to effectively clean the air of certain microbes.

A Yes, certain particulates.

Q In relation to that concept of filtration, is that always fixed within a system or can there also be mobile filtration units?

A You can utilise mobile filtration units-- have become far more prevalent within the last two years but, generally speaking, the efficacy of an in-room air cleaner or recirculating filtration unit is not a replacement for dilution ventilation because it doesn't remove odours or gases, it will only filter particulates.

Q Just so I'm understanding that clearly, it's not it's not generally a substitute because it's only filtering the particulates, is that right?

A In my opinion, it is not a substitute for dilution ventilation; it does only filter particulates.

Q If I could ask you to please have an in front of you, from bundle 1, document 10, which is at page 968. So is that a document headed up: "Appendix 1: Typical AHU Plant Layouts"? Do you see that?

A Yep.

Q What do we see in the top diagram?

A That is a graphical representation of a typical ventilation system and air-handling unit serving an operating theatre.

Q If we talk-- if we start in the top left-hand corner, we see "intake"; what's happening in the top left-hand corner?

A When you're assessing ventilation and performance of ventilation, the assessment actually starts before the air intake. So you need to make sure that the area where you are drawing the air from is safe and suitable. You would not, for example, want an extract louvre immediately beside an air intake louvre because you would be drawing contamination that you have removed from the area straight back into the area by means of the intake. You would also generally assess the intake

area or area immediately around the air intake to ensure that it was free from external contamination, rotting vegetation, bird fouling, etc. Once you get through the air intake, the air intake is equipped with a weatherproof louvre to minimise the risk of rain or water ingress to the air handling or ventilation system. It is also equipped with what is called a vermin guard, which is a mesh, normally metal, between 6 and 12 millimetres in size to prevent large contamination or indeed wildlife getting into the air intake area. You then go----

Q So just to be clear, what we're talking about here is there's fresh air coming in to the intake, is that right?

A Yes.

Q And you've said that there has to be an assessment of the-- effectively of the air quality where you're drawing that air from?

A Yes.

Q That's then going into the system, and you've already clarified that there's various louvres to stop ingress of vegetation or animals or the like. So once the air is drawn in, we see that there's a reference to an "attenuator" – what's that?

A If I can just complete the air intake, the air intake, if it is not

completely self-draining to prevent water ingress then it should be fitted with a suitable drain so we do not get any ponding of water within that air intake section. I mentioned earlier. fungal spores, fungal spores are of themselves ubiquitous, they're all around us all of the time, but they generally only become seeded and give off and spore when they are subject to moisture, so it is very important that we keep ventilation systems as dry as possible to prevent them supporting or encouraging any proliferation of fungal contamination. From the air intake, if it is either self-draining or has a drain fitted, there is then an attenuator which is designed to prevent noise transmission from the plant back into the general area. It's also colloquially known as a silencer. So it's there to prevent noise pollution leaking out from the plant back to the general environment around the air intake.

Q You've drawn the air in, and then effectively there's a process so that the noise is reduced.

A Exactly the same on your car exhaust, it has a silencer to prevent the noise of your engine being transmitted. If you blow your silencer, you realise just how noisy your car is. It's exactly the same for an air intake

attenuator. It prevents noise transmission from the air-handling unit back out into the general environment. From the attenuator, you then go through a motorised damper which is intended as a shut-off device. So if you are working on the air-handling unit or you turn the air-handling unit down, it prevents air coming in from outside and turning the fan blade whilst a maintenance technician is working on the fan or indeed air blowing through the air-handling unit when it's not desired.

From the motorised damper, you then go to a fog coil which is a preheat – sometimes also called frost coil – and it is there to prevent any air that hits the primary prefilter from containing moisture or freezing in the event of very cold, wet, or foggy conditions. If a filter becomes wet, again, it is the primary location where you capture particulate matter, you don't want it getting wet because that will again encourage proliferation of micro-organisms, but you also don't want it to freeze because that will cause it to have physical damage and potentially collapse and therefore you would be taking unfiltered air into the main air-handling unit. You then have the fan section, which basically----

Q Just before we----

A Sorry.

Q -- come onto the fan, I'm just trying to think, so that the air's come in, it's been silenced, moisture has been taken out of it. There's then a reference to a primary filter. So what's happening at the primary filter stage?

A The primary filter is removing particulate matter to a relatively core standard typically. You can filter it to a very high standard if desired, and it is there to protect the other mechanical elements and devices of the air-handling plant. So it stops your fan getting dusty, it prevents the heating coil, cooling coil, or heat exchangers clogging up with dust from outside.

Q Then we see, next to that, we've got the supply fan – what's it doing?

A It's moving the air.

Q How do you determine what specification of supply fan you'll need?

A You would select the fan based upon the required airflow performance of the ductwork, taking into account the volume of air that you are looking to deliver to each room and the acceptable velocity of that air through a duct distribution system.

Q Does the type of fan that you need and its performance depend on the overall system, including the ductwork you've described?

A It's an integral element thereof, yes.

Q Again, we'll come back to this, but it's really-- although it's a lot of component parts, you've got to consider the whole system when you're designing it.

A Yes.

Q Once the fan's turning in the air has been drawn through, we then see a reference to a run-around coil. What's a run-around coil?

A All air handling units now, by legislation, are required to employ some degree of energy recovery. The idea of healthcare ventilation is that we do not recirculate the air, we recirculate energy. So----

Q Why wouldn't you recirculate the air?

A Because you wouldn't-- you would either need to filter it to a very high grade to remove gases and odours as well as particulates. So we rely on fresh air dilution rather than recirculated air because, generally, we live in a temperate climate and it is more efficient to use dilution ventilation rather than recirculated ventilation. The run-around coil can actually be one of three typical heat recovery or

heat recuperator devices; it can either be a run-around coil, a plate heat exchanger or a thermal wheel. The run-around coil is basically a coiled-- a metal-finned radiator, for want of a better term, that there is one within the exhaust duct and one in the supply duct in the location indicated within the air-handling unit, and water or another medium is circulated between those coils to take heat energy or potentially cool energy from the exhaust air and deliver it back into the supply air. So it acts as a preheat or energy recovery device minimising the amount of energy that is required from the secondary heater battery; the principal heater battery comes later in the unit.

Q So if I can just ask you to pause there. You mentioned a concept of a thermal wheel. Is a thermal wheel different to a run-around coil?

A Yes.

Q How do they differ?

A Right. Can I do these in order just to keep them straight in my mind?

Q Yes.

A Run-round coil is a coil in the supply, a coil in the extract, circulate water through the coil. There is no direct contact or risk of leakage of air from the supply to the extract

because it is via a second medium, i.e. the water. A plate heat exchanger is where you have the supply air coming in and passes through a multiple plate matrix which has exhaust air going in the opposite direction, and you get thermal transmission between those plates. Again, the airstreams are not designed to cross, so you have minimal risk of any crossover of exhaust and supply air. Although, as with any manufactured device, there can be an element of leakage between those plates.

Final option is a thermal wheel which is, in basic terms, a spinning perforated disc which cycles through the supply air and then through the exhaust air. Normally the unit, in fact, for a thermal wheel, they have to be mounted one on top or one beside each other, and, as the thermal wheel slowly rotates, air that passes through from the exhaust transmits its heat into the thermal mass of that wheel, but when the wheel then rotates into the supply air, that heat is given up into the fresh air coming in. Again, thermal wheels can use both heat exchange and cool, but it is basically an energy transfer device. Primary difference with a thermal wheel is that because of its very nature and design, and you have to leave enough space for the

wheel to spin, there is a small percentage of leakage possible between the supply and exhaust. So, if you were exhausting air from a potentially highly infectious environment, thermal wheel would not be an appropriate means to transfer heat. You would want something that minimised the risk of that transfer. In general usage, thermal wheels have a very low proportion of leakage, one to the other, supply to extract or extract to supply, and are therefore deemed acceptable within the majority of healthcare environments.

Q If I can just be clear, what are the risks associated with using a thermal wheel in a hospital environment?

A There is the small risk of crossover air moving from exhaust into supply. But probably, from my perspective and practical experience, the biggest problem with thermal wheels is that they need to be maintained to quite high standards and levels of cleanliness to employ their efficacy. So, to get the maximum heat transfer, a thermal wheel must be kept fully free from debris and contamination. If it doesn't and it does become blocked, not only do you lose efficiency of energy transfer, it can also significantly impact on airflow.

Q In your view, would it be appropriate to use a thermal wheel in relation to an area of a hospital that would be dealing with immunosuppressed patients?

A Personally, I would not recommend it.

Q Why not?

A Because of the risk of potential cross-contamination and the amount of downtime that is needed to maintain and clean it.

Q Thank you. If we could then just return to the diagram on page 96, please.

A Well, then----

Q I think we have dealt with everything up to the run-around coil. If you could assist us with what is referred to as the cooling coil eliminator, please.

A After we've recovered as much energy from the exhaust air as we can, the air then passes through a cooling coil. The cooling coil can have two effects. It can be used to reduce the temperature, fairly obviously, but it can also be used to remove moisture from the air where humidity control or relative humidity control is required. The eliminator is fitted to the downstream face of the cooling coil to prevent moisture traveling beyond the confines of the drainage system. As I

mentioned within the air intake and indeed within the recuperator, drainage systems are required because moisture can condense out of the air at that point and we want to remove that moisture from the airstream as quickly as possible and not allow it to pond or pool within the air handling or ventilation system. So the eliminator plate forces the air through what is effectively a chicane and drives moisture down so it runs down into the drip tray and the drainage system that is shown on the diagram.

Having gone through the cooling coil, it can then be necessary to pass through a heater battery. A heater battery, as the name suggests, would increase the temperature of the air, but in increasing the temperature of the air, you can also dry the air out so it is a further addition to the control of humidity. What isn't shown within the typical air handling unit in this diagram was in previous versions was the provision of then a direct steam lance or humidifier which can add moisture back to the air should it be necessary or required under the environmental matrix conditions. Once you've gone through the humidifier-- and the order of those components, cooling coil, heating coil, humidifier, are critically

important----

Q If I could just----

A -- because if you get them in the wrong order, they don't work.

Q If I can just be clear, what do you mean by a steam lance or a humidifier?

A It's a point of direct steam injection into the airstream that provides moisture into the air without altering its temperature.

Q Why might you need that?

A Because if you want specific humidity control within a space-- for example, the quality of image received from some CT scanners is dependent upon the environmental conditions within the room, including humidity. So the clarity of picture can be influenced by the relative humidity within the space.

Q Thank you, Mr Poplett. I think I cut you off whenever you were about to tell us about the exact sequencing that that needs to exist.

A The exact sequencing is important. It must be cooler battery, heater battery, then humidifier, if you have a humidifier. Humidification is generally not widely used within healthcare and certainly is generally limited to specific environments where

humidity control is of critical importance. Those are generally burns units or large open wound operating theatres where, for example, a chest cavity is open for a prolonged period of time and you don't want the wound to dry out during the procedure, which leads to subdermal scarring. It used to be that we controlled humidity very closely because of the use of anaesthetic gases, some of which were explosive, and we wanted to control the humidity to minimise the risk of static electric discharge. We no longer use those anaesthetic agents, and therefore humidity control for explosive purposes is less of an issue. However, there is some emerging evidence to suggest that direct micro electric shock during cardiac surgery could be an issue where humidity control is, again, considered necessary but, at the moment, that is not the case.

Once we get through the humidifier, we then go to the secondary filter. That is where we can take the air, in terms of its particulate content, down to a level that is suitable for the patient environment or clinical environment which we are serving. It then goes through a further motorised damper which, again, is there. So if we turn the air handling unit off, don't

get any backflow from the rooms up through the unit and it effectively isolates the air handling unit whilst working on it. Through a delivery attenuator or silencer, it, again, removes noise transmission from the plant down into the clinical space. Where it's passing through a fire barrier or the soffit, in this case of the drawing, it goes through a device marked FD, which stands for fire damper. That could be a fire damper or it could be a fire smoke damper. There is a difference between them. I don't know whether you want me to go into that level of detail. It then gets delivered to the clinical environment via the ductwork. You will see from the lay-up prep, in this design there was clearly a need for a different temperature control within lay-up prep to the main theatre. Therefore, it has what would be described as a reheat or trimmer battery that is mounted remotely from the air handling plant and provides individual temperature control on heating to the lay-up prep as opposed to the operating or anaesthetics room in this diagram.

Q So what is the trimmer battery then at the end doing?

A It's a reheater. So, if you want the lay-up prep to be two degrees higher than the operating theatre, then

the trimmer battery-- you supply air at the right temperature for the operating department and the trimmer battery does that final increase by two degrees for the lay-up prep room.

Q And you have mentioned at various points “ductwork”. Can you just be clear, in this diagram, where are we seeing the ductwork?

A The grey material that is throughout the drawing. It's the means by which we transmit the air.

Q Then in the bottom of the picture, both on the left and the right-hand side, we see the word “extract” written. What should we understand that to mean?

A Those would be at the points within the rooms where we extract air, so we provide extract ventilation at low level within this environment or typical layout to ensure a clean air path across from the supply grill over the patient area and extracted at low level or within-- and the same within the anaesthetics room to make sure that any contamination within the room doesn't get drawn back up to the ceiling. It gets exhausted at low level, at floor level.

Q What would we see through the extract grill? What would you need there to make the system work?

A You would typically have ductwork, again, leading back up to the plant area. It then either goes through an extract air handling unit, as I've described, with a thermal wheel, a double-deck arrangement with the supply unit, or it could be extracted by a separate independent extract fan. The extract fan itself is built up from a return air filter to protect the fan itself from any particulates that are removed from the operating theatre. It then passes through the fan, through an energy recovery device, the other half of the run around coil, to then-- before it gets discharged through, normally in a further exhaust attenuator and to an exhaust louver.

Q Am I right in thinking that if we boiled all of this down, you have got the fan drawing air in, there are then various processes where the air is treated, and then you have either a fan or some other process that draws the air back out of the space?

A Yes.

Q In relation to other aspects that could form part of a ventilation system in a hospital, the term “chilled beams” has been used at various points in the Inquiry. But what is your understanding of a chilled beam?

A Chilled beams fall--

There are two types of chilled beam, passive and active. A passive chilled beam is, in effect, a radiator, but instead of heat, it puts out cool. It is a radiator-type arrangement, normally ceiling-mounted, where warm air rises within the space through convection, it comes into contact with the chilled beam, it cools that air down, that air then drops through convection back down into the room and is replaced by further warm air from within the room, and so it is a basic convection cycle device. You can also get active chilled beams, which are exactly the same as a passive chilled beam but can include a degree of fresh air supply. So there would be a ducted supply of air delivered to the chilled beam to provide an element of fresh air dilution, and it would then cycle through the chilled beam as previously described. You can also get-- if you use refrigerant, you can get chilled beams for both heating and cooling, which are sometimes referred to – and I believe in one of the documents – as a "comfort unit". These use refrigeration cycle as well as the convected air current approach to either heat and cool the air when required.

Q Just to make sure that I am understanding things, at its most basic level, a chilled beam would be

about cooling the air in a space? You could have a more complicated arrangement that both heat and cools the air within the space----

A Correct.

Q -- and the system may or may not have some form of fresh air involved?

A Correct.

Q In your opinion, are there any particular risks associated with the use of chilled beam technology in areas of a hospital where mechanical ventilation is required?

A My personal belief, and it's reflected within the HTM, is that chilled beams are not appropriate for use in treatment clinical areas. The reason is twofold. First is that, in terms of cooling air, you will naturally condense moisture from that air. That moisture does promote the proliferation of micro-organisms. So we don't want air mixing with water, and certainly not water that isn't drawn away quickly, because it would promote or sustain microbiological proliferation. The other issue with chilled beams is that they are highly effective and very good in terms of energy usage, but they do require good maintenance to keep them operating in a satisfactory condition.

Where you have a clinical

environment, you do not want maintenance personnel going in with ladders and tools and equipment more often than is absolutely necessary because, without any disrespect to the maintenance technician, they are equally a source of potential contamination and risk to the patient and disruption to the clinical activity.

Q So you mentioned that they would need a lot of maintenance. What type of maintenance are we talking about?

A They would need inspection and cleaning at least quarterly.

Q You mentioned that you wouldn't advocate using chilled beams in treatment clinical areas. Just so I'm clear, what do you mean by that within a hospital?

A Within a hospital-- Within a typical district general hospital, I would consider that as bedroom spaces, ward area, patient overnight spaces or treatment spaces where ventilation rates were critical.

Q Again, just to be clear, in terms of the risks, what risks, if any, are associated with chilled beams potentially being used where there's immunocompromised patients?

A Well, as I say, they naturally, as part of their function,

condense moisture out of the air; that moisture goes into drip trays, drainage trays, and then is either drained away through gravity or by condense pumps. As soon as you introduce moisture and potential wet surfaces into that environment, if you have fungal or microbiological airborne activity, it will tend to proliferate within that moisture.

Q You'd mentioned a term, a "comfort module". What do you mean by a comfort module?

A It is basically a chilled beam but has heating as well as cooling capacity.

Q I'd like to now ask you some questions just about filters and filtration. What is a high efficiency particulate filter?

A A high efficiency particulate filter or HEPA is a grade of filter which will take out a very high percentage of very small particles.

Q What type of particles?

A It doesn't differentiate on the type of particle, it differentiates on size of particle and the capacity or efficiency of capturing those particles. So, if you look at a typical filter, EPM 1 at 50 per cent or the equivalent of what used to be called an F7, that will capture 50 per cent of micron-- of particle sizes, one micron in size. A HEPA filter will capture particles down

to a much smaller grade of size, typically 0.3 or 0.4 microns, and will capture between 99.9 per cent and 99.9998 per cent of those particles from the air. HEPAs still do not filter out gases or odours. They are, as the name suggests, high efficiency particle filtration.

Q Again, just thinking back to what we've seen in the diagram, is that really coarse filters that we saw within that standard diagram?

A No, the coarse filters would be normally-- and in previous terminology G2 to G4, they are coarse filters that will take out relatively large particles at relatively low efficiencies. The secondary filter will take out finer particles at a great-- at a higher efficiency, capture far more of them. A HEPA is the top end of the spectrum, which will take out the highest percentage of down to the smallest grade. HEPA will also filter out large particles. It won't just filter out the little ones; it filters out to a far finer grade. So the analogy I would use is that it's the difference between a colander, a kitchen sieve and a muslin cloth. You've got different grades of filter capturing different sizes of particle.

Q Can you have a portable high efficiency particulate filter system?

A Yes. However, they do not provide any fresh air. They only provide cleaning to the air that's within the void. So, again, they shouldn't be seen as a replacement to dilution ventilation. They can remove particles within-- that are within the room.

Q Would there be any issues associated with them being used in areas that had immunocompromised patients?

A One of the challenges with using air cleaning devices, particularly where you have extremely vulnerable or critical care patients, is space. There are umpteen machines that are working on keeping those patients, monitoring their conditions, keeping them alive. They're on, potentially, a ventilator; they have infusion pumps; they have monitors. There's all manner of equipment within those rooms. To add to that a recirculating cleaning device for the air takes up floor space, adds to the heat load, adds to the noise and the difficulty that both clinical communication can have, but also, in-- other than the highly critical care areas, it's actually good for the patient to be able to go to sleep. If you have a Henry Hoover running in the background constantly, it is challenging for people to sleep through

that. So recirculation devices introduce noise directly to the clinical area, which is not ideal for the patient.

Q In your experience, should there be a requirement to add a portable high efficiency particulate filter to a space that already has a high efficiency particulate filter fitted to the ventilation system?

A Generally speaking, no. If the air change rates are adequate, you shouldn't need supplementary HEPA within an area that already has HEPA-filtrated air.

Q If you saw a space whereby there was a-- what you refer to is a portable or a mobile HEPA filter and there's already a HEPA filter there, what questions would you be asking?

A "Why?"

Q And what conclusions might you be able to draw after those investigations or is that impossible to say?

A It would very much-- I would imagine that it's been driven by a clinical request, either through IPC or the clinicians. I would want to understand what their understanding is that the unit contributes to that patient environment.

Q What types of patient environments would require a high efficiency particulate filter?

A Most commonly immunocompromised or neutropenic areas would certainly require it. Other areas are within operating theatres where UCV canopies or ultra clean ventilation canopies are deployed, for a number of the royal colleges have identified that certain surgery should only be undertaken where UCV theatres are operating. A UCV theatre is a variant from the example shown in bundle 1, document 10, which, instead of the grills going directly into the room, they deliver the supply air into what we call a air plenum. That plenum is fitted either with single or multiple recirculating fans that take the air-- supply air, add it to air that's been extracted from the room and push it through a tertiary, third stage HEPA filtration level. Generally speaking, UCV theatres will operate at somewhere between 4 and 600 air change per hour under the canopy volume and provide HEPA-cleaned, if you like, recirculated air within the void, but it is supplementing already fresh air dilution ventilation provided by the air handling unit and extracted in the way described in the typical layout.

THE CHAIR: My fault, Mr. Poplett. A UCV-- "C" may be canopy, "V" may be ventilation, I missed the

"U".

A Ultra.

Q Sorry?

A Ultra.

Q Thank you.

MR MACGREGOR: Lord Brodie, that's just before 11.30. I was going to move onto a different chapter of questions, so if your Lordship's minded to take a break----

THE CHAIR: Yes.

MR MACGREGOR: -- now may be an opportune moment.

THE CHAIR: That would seem appropriate. As I said, Mr Poplett, we planned to take a mid-morning break. The clock tells us a little before half-past, so if you could try and be back by quarter-to.

(Short break)

THE CHAIR: Mr MacGregor?

MR MACGREGOR: Thank you, my Lord. Mr Poplett, just a few questions still dealing with the diagram that we've looked at previously and the questions that I've asked you. In relation to thermal wheels, you mentioned that you wouldn't recommend that they're used in certain areas of hospitals. Is there any guidance in relation to such issues?

A No.

Q What's your view based upon?

A My view is based upon experience and my assessment of potential risk and disruption or maintenance requirements of the various different systems.

Q Similarly, in relation to chill beams, you suggested that you wouldn't recommend that they're used in areas, for example, involving immunocompromised patients. Is there any guidance in relation to such issues?

A Within the current HTM they are specifically recommended against their use unless it is subject to specific risk assessment and approval by the Ventilation Safety Group.

Q So that's for latest guidance, which I think is 2021 onwards, is that correct?

A Correct.

Q So what was the position under the previous guidance?

A I would need to double check, but I believe that they were still not recommended for clinical areas.

Q Certainly if we're thinking the period before 2021, would you have recommended their use in those areas we've discussed?

A No.

Q Why not? What's your

view based upon?

A Chilled beams are incredibly effective and useful in certain environments. They are highly energy efficient and very effective in stable environments; office buildings where you have sealed windows and no fresh air, it's great – they are frequently deployed and highly effective. Where you have a dynamic clinical environment, such as within healthcare, and you have issues of microbiological and airborne contamination risks, I don't believe they're an appropriate solution.

Q Thank you. If we could return to the diagram that we've been looking at, which is in bundle 1 at page 968, so that's the diagram of the ventilation system in the operating theatre. You see the bottom left and the bottom right, we've discussed the extract grilles. Where would the air be being extracted to?

A It would be extracted to outside. So they would-- as part of the ventilation strategy, you are putting in a certain amount of air into the area to achieve an air-change rate. Some of that air you want to leak out to surrounding areas to provide the clean air path, the clean to less clean environment we discussed earlier. Other areas, because of the sheer

volume of air we're talking about, you want to extract directly from the space because you don't want that contamination either transferring to the surrounding areas or it's just a case of "We've got enough air leaking out through the natural air path and air leakage rates to provide the right pressure cascade or pressure differential", and therefore the remaining is extracted and passed through the extract element of the air-handling unit, energy recovery is effected on it, and it's then discharged back to the atmosphere.

Q If you had a build-up of moisture at the extract grille, would that be problematic?

A It would be less problematic than if it was within the supply system because the extract grille and ductwork is, by its very nature, under an air path that is away from the patient area; but it is not an area where you would want microbiological activity to proliferate because, when you shut the systems down, they effectively fall under neutral pressure, and it would be possible to get contamination back out the extract duct into the area.

Q I think the final issue is, just in fairness to you, we discussed Dr Lidwell's formula and you talked about

the 63 per cent dilution, and then it would be 63 per cent on that. Again, I appreciate you don't have a calculator, but if we did look at those numbers, would it possibly be, with one air change, we'd be looking at 63 per cent dilution?

A Yes.

Q Then possibly, if we modelled that on, then with two air changes, you're bringing that down, the base figure would be approximately 37 with approximately an 86 per cent dilution rate.

A From the original, yes.

Q From the original, and then so on. At three air changes, you would be at 13.69, approximately 94 per cent from the original.

A Yes.

Q Does that make sense?

A That sounds correct. As I say, the only *proviso* or two *provisos* that that must be with full-room distribution, it can't be in the left-hand corner and out the left-hand corner and not touch the rest of the air, and it can't be used if you are continuing to release contamination into the space.

Q If we continued that on, at four air changes we'd be down approximately 5.07 and touching approximately 98 per cent from the original contaminant.

A Yeah.

Q If you model it on, you get down to, as you said, at six air changes per hour, you're talking approximately 99.8. (After a pause) If I can ask you to return to your statement, please, so paragraph nine, which is on page 101 of bundle 6. Paragraph 9, you begin to explain about Health Technical Memoranda and other guidance such as Health Building Notes. Can you just explain to the Inquiry what are you meaning by this guidance?

A HTMs, HBNs are guidance issued by the Department of Health to inform those involved in construction and operation of healthcare facilities the technical and spatial issues associated with their design and operation. So they are broken down, in terms of HTM, into eight categories, one for each engineering or specific technical discipline, seven in reality, with the eighth being the-- anything that doesn't fit in the first seven approach, and HBNs are documents that are suited down by clinical activity. So you will have an HBN for mortuaries, you would have an HBN for X-ray departments or imaging, you will have a HBN for acute inpatient areas or outpatient areas or-- so the HBNs are

driven by clinical activity, the HTMs are driven by individual engineering or service disciplines.

Q Within the Health Technical Memoranda, we have got one general Health Technical Memoranda, is that correct?

A You have the 00 Core Standard, which is basically how all HTMs should be managed and considered – that's the umbrella HTM – and under those you have the individual engineering or subsections.

Q And in terms of those subsections, as you say in your statement, you would, for example, have a separate Health Technical Memoranda for water and then one for ventilation?

A Yes.

Q If you have that guidance, the Health Technical Memoranda, what exactly are the Health Building Notes and other associated guidance? How do they fit together?

A The engineering, or HTMs, talk about services such as ventilation or water or electrical. The HBNs talk about clinical activity and spaces. So they also-- HBNs also cover the technical building aspects, so it will cover things such as sanitary appliances, so what your wash handbasin should look like, what's the difference between a wash handbasin and a sink, what toilets are, what the spacing of those are, if you've got disability or accessible facilities, how they should be configured and operated. So HBNs talk about either building discipline or clinical activity disciplines. The HTMs talk about the engineering services, so ventilation, water, etc.

Q If we just take as one example, if we look in bundle 2, please, document 10, page 832, we should see "Health Building Note 04-02, Critical care units". Do you see that?

A Yes.

Q Is this specific guidance relative to critical care units?

A Correct.

Q If we look onto page 835, we see the preface there, "About Health Building Notes," which states:

> "Health Building Notes give 'best practice' guidance on the design and planning of new healthcare buildings and on the adaptation/extension of existing facilities.
>
> They provide information to support the briefing and design processes for individual projects in the NHS building programme."

Do you see that?

A Yes.

Q So is that your understanding of the purpose of this type of document?

A For Health Building Notes, yes.

Q If we then look on to the next page, please, to page 836, we see on the left-hand side, there is the bold heading, "Other resources in the DH Estates and Facilities knowledge series". Then there is a reference to "Health Technical Memoranda":

> "Health Technical Memoranda give comprehensive advice and guidance on the design, installation and operation of specialised building and engineering technology used in the delivery of healthcare … They are applicable to new and existing sites, and are for use at various stages during the inception, design, construction, refurbishment and maintenance of building."

It then goes on to say:

> "All Health Building Notes should be read in conjunction with the relevant parts of the Health Technical Memorandum series."

Is that your understanding of how the guidance should be read?

A Yes.

Q On the right-hand side, there is a reference to "Activity DataBase (ADB)". Do you see that?

A Yes.

Q Just before we read it out, what is your understanding of what Activity DataBase is?

A ADBs provide, if you like, a starting point for any design. So the ADBs will cover typical rooms, layouts, what those rooms should contain, how those rooms should perform. You would then take the ADB as a skeleton framework to then look at the specific clinical requirements of a specific HBN or indeed any limitations by reutilising or refurbishing existing buildings to apply or fill in the gaps or tailor it to be specific for the clinical activity that is being planned.

Q Physically, how would you find it? Is it a hard-copy guidance like a Health Building Note?

A It's not an area where I have current sort of practice in doing, but my understanding is that it is a software system which is accessible through NHS which gives you the information in an auditable and adjustable format.

Q You say you do not have current experience. Have you historic experience of using an activity database?

A ADBS are generally used when creating room data sheets, or RDSs, when you are planning a project at the design concept stage. As I say, it gives you your starter for ten that this is what we would typically expect to find and require. It is then tailored by the specific clinical requirements, as detailed in the HBN, or if an HBN is not specific for that area, a particular clinical practice. As I'm sure you'll appreciate, clinical practice develops more quickly than HBNs are written around that clinical practice. You have to invent something before you can write a book about it.

Q So just to be clear, you mentioned the term “room data sheets”. What is your understanding of room data sheets?

A When you undertake a project, you will typically find that every room within that scheme will have its own individual room data sheet. That room data sheet will capture the fundamental elements of what that room exists. It will very frequently include the environmental, how many sockets, what medical gases, how

many outlets would be in, what air change rate you might expect from the ventilation system, down to lux levels that you would expect from the lighting, provision of fire alarms, a whole raft of individual specific technical elements that principally are covered under HTMs but are specifically scheme-captured in the RDS room by room.

Q Just so that I am understanding things: a room data sheet and the activity database, are they the same thing or are they different things?

A The ADB is where you start your room data sheets from. You then tailor your room data sheets specifically to the clinical activity that you are looking to provide. So an RDS is unique to that room in that project, a DBA-- ADB – I hate the acronyms that the NHS use – is used as the starting point where you would say, “Well, typically, we want the toilets to have this level of ventilation, that level of lighting, a toilet pan, a wash handbasin, a coat hook on the back of the door,” etc., etc. The RDS is then, in this particular application, “Is that the right level that we want in that room in this circumstance?”

Q Now, my understanding is the activity database is effectively a

database of options. You could then create a room data sheet for an individual space.

A It's the starting block for an RDS, yes.

Q Okay. Just returning to Bundle 2 at page 136, "Activity DataBase, it states:

> "The Activity DataBase (ADB) data and software assists project teams with the briefing and design of the healthcare environment. Data is based on guidance given in the Health Building Notes and Health Technical Memoranda Building Components Series. Room data sheets provide an activity-based approach to building design and include data on personnel, planning relationships, environmental considerations, design character, space requirements and graphical layouts."

What is your understanding, when you have used an activity database, of what is meant by "environmental consideration"?

A It's what environmental conditions you are requiring within that space to undertake the planned clinical activity.

Q Would it include issues relating to engineering and ventilation in particular?

A Yes.

Q Would it include levels of detail, including air changes per hour?

A Yes, where they're applicable.

Q Again, just so I am understanding this: if you go into the activity database and create your room data sheet for a specific space, that will automatically be drawing out values that are set out in things such as Health Technical Memoranda and Health Building Notes?

A It will be drawing out the typical values. You still need to check that those typical values are appropriate for the clinical activity for which you are planning the space to be used.

Q Okay. So it is a starting point, but it would then have to be reviewed. So if we just return, still on page 836, at number 2:

> "2. Schedules of equipment/components are included for each room, which may be grouped into ergonomically arranged assemblies.
>
> 3. Schedules of equipment can also be attained at department and project level.

4. Fully loaded drawings may be produced from the database.

5. Reference data is supplied with ADB that may be adapted and modified to suit the users' project-specific needs."

What is your understanding of all those terms, that it can be adapted and modified?

A It's exactly as I've described. You would take the ADB and convert it into a project-specific RDS.

Q If we could then move on, please, still within bundle 2, but this time to go to document 11, please. Document 11 on page 859. That should be the Health Building Note 04-01, Supplement 1, "Isolation facilities for infectious patients in acute settings". Do you see that?

A Yes.

Q Have you seen this before?

A Yes.

Q Again, if you could just explain, what is this? It is obviously a Supplement Building Note, but why would a supplement be needed?

A A supplement is generally issued where there is a requirement for a new kind of room or new kind of clinical environment that hadn't been previously or suitably covered by an existing HBN. So, in terms of the isolation facilities, this was developed because there were issues with isolation facilities within NHS settings, and it outlined a strategic approach to take when considering and designing isolation facilities.

Historically, there have been, and still remain, isolation facilities that are known as switchable. So you give the user control, normally to a nursing staff member, to make the room either positive or negative depending upon the nature of the patient that they were treating. Nurses have a hard enough job and are overworked far too much already to worry about knowing ventilation standards and knowing the difference between positive and negative ventilation and when such ventilation should be applied to different patients. So the HBN, when it was produced, it is specifying either different grades of isolation facility, but it introduces the concept of what is known as a PPVL, or positive-pressure ventilated lobby, and that is a design concept which is intended to be appropriate for either infectious or neutropenic patients without any change in its engineering approach other than the grade of filtration that is provided.

Q Giving very specific guidance on a particular aspect of a ventilation system?

A Yes.

Q Again, if we just look on, still within bundle 2, the same document, page 864, we should see the executive summary of what is then set out in the detailed note to those. So page 864:

> "This Health Building Note sets out practical guidance on how to provide safe, effective isolation facilities for infectious patients (source isolation) that are simple to meet the needs of most patients on acute general wards."

Then it goes on to state what the guidance is going to set out. Do you see that?

A Yes.

Q Then at the bottom it says: "It's advised at this Health Building Note be read in conjunction with," and then there is a list of guidance that follows thereafter.

If we put that to one side, and if we return to your statement, please, that would be in bundle 6, page 101, paragraph 9, please. So, at paragraph 9, you have set out a series of bullet points. You start with the "Nuffield Functions and Designs of Hospitals". Why did you include that?

A It provides basically just a history of when ventilation in particular started being recorded and considered as a specific consideration within healthcare.

Q Then you work through. So there was the Operating Department and an HBN, so is that a specific HBN from the 1960s?

A Correct.

Q We have then covered off the work done by Dr Lidwell in the 1970s, and that then takes us up to what you have called DV4 in 1983. What was DV4?

A DV4 was a Department of Health publication that covered ventilation for operating departments and was the precursor to HTM 2025.

Q Then, from 1994 onwards, we see reference to the Health Technical Memoranda 2025, is that correct?

A Yes.

Q Really then, you have set out further guidance, so you have the Health Technical Memoranda 03-01 in 2007. How did that differ, just in general terms, from Health Technical Memoranda 2025?

A It was part of a move from the 20 series, as they were generally known, through to the 0

series of HTMs, so it was a reformatting. It was, as I understand it, a government initiative to try to slim down the number and volumes of guidance provided, and was particularly focused on the fact that the procurement methodology was changing within healthcare and it was more focused on the output rather than the technical content of any design.

Q Then we have got the current version, the Health Technical Memoranda 03-01 from 2021. Is that the most recent guidance?

A That's the most recent guidance.

Q So effectively, from the 1990s onwards, on a periodic basis, it is being updated?

A Yeah.

Q Why is that required?

A Technologies change, practices change, clinical activities change. Generally speaking, as you go through the various iterations, we have started to include far more examples of clinical activity than were originally included. So, originally, it was based very much around operating departments and operating theatres. As you will see from when you look at Appendix 2 in 03-01 2007, we've listed far more than just operating theatres as areas where

critical ventilation would apply. Again, if you look at the latest iteration in 2021, we've included an entire chapter – now Chapter 8 – that covers specific clinical activity areas where ventilation plays a part, and we've also expanded the aide-mémoire, which Appendix 2 forms.

Q So Health Technical Memoranda, who produces it?

A It is produced by-- it's produced under the control or authority of the Department of Health. They appoint a – normally – team to actually do the work, they appoint a lead author, and that lead author, in my experience on the ventilation standard, then compiles a group of individuals from varying backgrounds to contribute to its review and production. So if you look at the very start of the latest HTM, there is a list of around 40 names of individuals who were involved in the authorship of it.

Q You have used the term “we”. Have you been involved in the production of Health Technical Memoranda?

A I was involved and sat on as a committee member of the latest iteration of the HTM.

Q The Inquiry has heard evidence previously that the Health Technical Memoranda, although it

applies in England and Wales, it is produced on what was described as a "four-nations approach" with input from all nations in the United Kingdom. Was that your experience?

A Yes.

Q Again, you mentioned that there is a lead author and then there is a team of people. Who is in that team of people that are assisting with producing the guidance?

A It is a wide selection or variety of those working in the industry with specific knowledge. Some come from representation from named organisations, institutes or societies. So, in terms of the ventilation process, we had members representing the Chartered Institute of Building Services Engineers, we had people representing manufacturers, people representing commissioning and balancing engineers, we had people representing the SVH Society and authorising engineers, we had representation from IHEEM, we had representation from HSA UK as it is now, PHE as it was then. Having gone through the drafting process, drafts of the final document were then circulated to a wider group of Royal Societies and other institutes for comment/review before forming the final document as it is published.

Q In terms of the input, would clinicians have input?

A Yeah.

Q Microbiologists?

A Definitely.

Q Infection prevention and control individuals?

A Yes.

Q I think you describe it in your witness statement as being a "broad church of disciplines" that come together to create the guidance. Is that correct?

A Yes.

Q Who is the guidance aimed at?

A Predominantly the guidance is aimed at engineers and those responsible for designing, in terms of HTMs, the aspect for which they cover. They are also aimed at those who operate them and maintain them. So different parts-- If you look at the current HTM, it is broken down into a two-part document, Part A and Part B. Part A is intended for the development, design, construction and commissioning of systems, ventilation systems in the case of 03-01. Part B is aimed for the operation of all ventilation systems, whether they are brand new or historic. So the Part B is written to apply to any ventilation system, irrespective of the date of its

design. Part A is obviously aimed at new designs undertaken from the date when publication occurred.

Q Again, just so I am understanding, you mentioned that it would be aimed at engineers who are working in this space, both in design and maintenance of it. Would it also be aimed at those who are responsible for owning and managing healthcare facilities? So, in England and Wales, would that be healthcare trusts?

A Yes.

Q Again, just so I am understanding this, is it more than just simply a technical guide written by engineers for engineers?

A I think it very much is depending upon your role as to how much you would read and how much you would need to comprehend and understand. It should, at the very highest level, be understood that there are guidances and specific standards that need to be met. Does everybody at that level of an organisation need to understand all the nuances that go into the design of a ventilation system? No, that is not practical or feasible. However, for those with specific requirements of design and operation, they need to know, and at that point, it's for engineers specifically. But it is hopefully written in language that

easily explains to non-engineers why ventilation is important and where ventilation needs to be considered.

Q Thank you. In relation to the Scottish Health Technical Memorandum, the Inquiry heard evidence from a Mr McLaughlan who works for Health Facilities Scotland, and he described the Scottish Health Technical Memorandum in the following terms. He said that:

> "… those not close to the issue might assume they are an instruction manual handed out by government. This is not the case; they are the health service's interpretation of the responsibilities it has under the applicable legislation, regulation, codes of practice and government policy."

Would you agree with that?

A Yes.

Q If I could ask you to please look within bundle 2 this time to document 2 – so bundle 2, document 2 – at page 90. Do you see there what you have referred to, I think, as 00, so "Health Technical Memorandum 00, Policies and principles of healthcare engineering, 2014 edition"?

A Yes.

Q What is the purpose of this document?

A This document provides an overview of the management structure for all of the other HTMs.

Q So if we look on to page 93, it should be headed up in the top left-hand corner, "Preface." So page 93. Do you see on the left-hand side, third paragraph beginning, "Healthcare providers have a duty of care"? Do you see that?

A Yes.

Q So it says:

"Healthcare providers have a duty of care to ensure that appropriate governance arrangements are in place and are managed effectively. The Health Technical Memorandum series provides best practice engineering standards and policy to enable management of this duty of care."

Do you see that? So is that one of the objectives of this guide?

A Yes.

Q Can we then look on, please, to page 95? Page 95, on the left-hand side, the final paragraph in green, it says: "Activity DataBase (ADB)".

A Yeah.

Q And it says:

"The Activity Database data and software assists project teams with the briefing and design of the healthcare environment."

Can you see that?

A Yes.

Q Again, is that consistent with what you have told us already, that really you are looking to the activity database to assist with briefing and design in relation to ventilation?

A Yes.

Q It continues:

"Data is based on guidance given in the Health Building Notes and Health Technical Memoranda."

Then it says, "For ADB technical queries," and there are various contact details that are provided. So, again, I think, as you have already said, within the activity database, the values there are going to be based upon the guidance in the Health Building Notes.

A Yes.

Q If we then look on to the next page, to page 96, it should have in the top left-hand corner, "Executive summary." Do you see that?

A Yes.

Q This time, page 96, on the right-hand side, under the bold heading, "Aim of the guidance."

A Yes.

Q It says:

"The aim of HTM 00 is to ensure that everyone concerned with the management, design, procurement and use of the healthcare facility understands the requirements of the business-critical building and engineering technology in order to ensure optimum safety for all who are present in the building."

Do you see that?

A Yes.

Q Now, one of the things the Inquiry is interested in knowing is, in terms of this guidance, is it just general guidance or is it comprehensive guidance in relation to ventilation?

A Well, HTM 00 doesn't cover ventilation specifically. It is an overview of, if you like, all of the HTMs. The HTM for ventilation, 03-01, and, to a degree, the HTM 00 fulfils both minimum standards and best practice in-- depending upon which area you are looking at and which area you are considering. So I believe with HTM 00, the Core Standard, it states that everybody needs to be familiar with and aware of the requirements of this and follow it to ensure that there is a safe environment for the facility to operate. In terms of specifically for ventilation, it covers, as I say,

depending upon the individual clause or the individual application, could be in places considered as best practice, and therefore potentially open to derogation, or it could be in some places considered as minimum standard, therefore, I would position not subject to derogation.

Q We will come on and talk about the derogation as well. I would be interested in your views in terms of that paragraph whenever it states that really what we are looking at here is ensuring optimal safety for all who are present in the building. Why is that reference included in the guidance?

A Because, within hospitals, we don't just have to keep the patients safe. We also have to keep the staff safe and ensure that visitors and anyone who utilises the premises can do so safely.

Q It then continues in the next paragraph:

"Only by having knowledge of these requirements can the organisation's board and senior managers understand their duty of care to provide safe, efficient, effective and reliable systems which are critical in supporting direct patient care. When this understanding is expected that appropriate governance

arrangements would be put in place, supported by access to suitably qualified staff to provide this 'informed client' role, which reflect the responsibilities."

What is your understanding of that term "informed client"?

A My understanding is that a health board is responsible for the operation of an incredibly complex, at times, facility that not only deals with incredibly complex clinical issues, but also has with it technically challenging engineering and building elements. An informed client is to make sure that the client or board are fully appreciative of all of the elements that go up to make that safe environment. So you can't concentrate on only one aspect. You have to look at all of the aspects and how they interact with one another and what you intend to undertake clinically to provide and make sure that you can both provide and give assurance that that facility is safe and appropriate.

Q Thus far, I think you have covered off that this guidance, both 00 and specific guidance, would be relevant to engineers and it would be relevant to the board of the trust itself. Would other stakeholders in this area be interested in the guidance and whether it is complied with or not?

A I would like to think that

all stakeholders would be interested in it. Practically, the level of knowledge and commitment to read and quote it would be probably limited to those two groups. But, yes, it is fundamental to the operation of the safe environment. So you wouldn't appoint AEs unless this document said you should really have AEs. You wouldn't have, necessarily, authorised persons. This document structures that you need someone in the organisation who is operationally familiar to a sufficient level of competence with the technical aspects of any particular engineering discipline. So it is applicable to everybody, it's accessible and open to everybody. The level of familiarity and involvement with this document is probably limited by practicality rather than restriction of access.

Q Would regulators potentially take an interest in the document?

A Yes.

Q What regulators?

A CQC.

Q Whenever you say "CQC", what do you mean by that?

A Care Quality Commission.

Q Any other regulators?

A The Health and Safety Executive. Although HTMs don't fall

directly under HSE, they are considered by the HSE as a form of approved code of practice or best practice. So when they audit, they will check against both HSG standards, Health Safety Executive standards, such as 258 for LEV systems. They may also look at HTM 03-01 to look at ventilation aspects specific to healthcare, and HTM certainly reference back to HSG 258.

Q Do you have any experience of dealing with the Health and Safety Executive in relation to documents such as the Health Technical Memorandum?

A Regrettably, yes.

Q What interest, if any, did they take in compliance with the Health Technical Memorandum?

A Their primary focus is on health and safety guidance, i.e. the HSG, the HSE published guidance. However, they are also interested in and utilise the HTMs as, as I say, a form of approved code of practice.

Q Is there any specific examples that you could provide to the Inquiry?

A Three weeks ago, I was involved in an HSE inspection regarding water systems where the HSE inspectors were quoting and looking at both the HSG guidance and

the HTM guidance.

Q Would your expectations be the same in relation to ventilation?

A Yes.

Q If we can then look on, still within bundle 2, within SHTM 00, at page 97, top left-hand corner, you should see “Users of the guidance. Page 97:

> “Providers of NHS healthcare and operating facilities in England will be the main users of this document. However, other stakeholders, including regulators and inspectors, may also be interested and will expect that this best practice guidance is being followed or that, where this is not the case, healthcare providers can demonstrate how any best practice expectations are being met by equal and alternative means.”

Is that your understanding of this guidance? Is it best practice guidance?

A As I’ve said, I believe that the HTMs in various elements serve as both best practice and minimum standards. Overall, I personally consider them as an approved code of practice. So, in my expectation and experience, again going back to the water equivalent, I

would consider the HTMs to be of equivalent standing to L8 is in water; so it's not legislative, it's not mandatory in and of itself, however you need to be able to demonstrate compliance or a reason for non-compliance and measures that have been taken equal or better than the standard. Again, I would just remind you, I'm not a solicitor, I am just an engineer.

Q If we could look on still within the same guide, this time to page 110 please. I think you'd mentioned it earlier today that it was in SHTM 00 that you see the concept of an "authorising engineer" coming into being. Is that what we see set out at paragraphs 3.16 and 3.17?

A Yes.

Q You'll see at 3.16:

> "The AE will act as an independent professional adviser to the healthcare organisation. The AE should be appointed by the organisation with a brief to provide services in accordance with the relevant HTM. The professional status and role required may vary in accordance with the specialist service being supported."

What stage does an authorising engineer become involved at? Are

they involved at the design stage, or do they simply come into being once the healthcare facilities is up and running?

A That is a very good question and not easy to answer. An AE I believe, as an AE, has value to offer at pre-design stage, so the concept stage of a healthcare facility development. They certainly have a role to play in the design and design review to ensure that the proposed design meets the requirements of the HTM. They have a role in ensuring at validation that the systems actually deliver what the design and intent and clinical output spec was to be achieved. They then have a function to play in terms of ensuring the ongoing operation, and ultimately decommissioning and disposal, are undertaken again in conformance to the requirements of the HTM. So when to involve an AE is very much driven by the complexity or the nature of the project development. As an AE, I would not expect to be involved in the designing-- back to my original, very simplistic project of a new toilet with a new toilet extract fan. Where you are planning a new respiratory illness unit or a new building within an existing estate or indeed a new hospital, then I would expect an AE to be involved at

design concept prior to design to ensure that it complied in terms of the client being an informed client was asking the provider to provide what they actually required.

Q In your opinion, an authorising engineer should be involved as an independent person right at the start of a project for an acute hospital?

A Yes.

Q Is that set out in any legislation or in any guidance that you're aware of?

A No.

Q We then return, please, to page 110, this time at paragraph 3.17:

> "The AE will act as assessor and make recommendations for the appointment of Authorised Persons (APs), monitor the performance of the service, and provide an annual audit to the DP."

Now, if we take those in turn, what's the reference here to an authorised person? What does an authorised person do?

A The authorised person role is, in practical terms, a site-based individual with sufficient technical knowledge of the engineering discipline and the specific engineering

installation on the site to manage the day-to-day operation of the ventilation system.

Q Does the authorised person come in once the facility is up and running?

A Generally, yes, if it is a new facility. If it is an existing facility that's being extended or replaced, then the operational AP should normally be involved at the design stage in conjunction with the AE to ensure that the final project is maintainable and is suitable for continued operation post-project handover.

Q So, in your opinion, again, if we think of this example of building a brand new acute hospital, there should be both an authorising engineer and an authorised person appointed right at the start of the project.

A There will normally be an AP-- unless we are talking about starting a hospital from scratch, they normally come from an existing healthcare facility. So that AP will exist, they should be involved at design stage and at concept stage to ensure that the final design and therefore final project is maintainable because that's going to be their role once the project has been finished in terms of construction.

Q That's obviously your opinion but, again, is that set out in any legislation or any guidance as far as you're aware?

A No.

Q If we could return to paragraph 3.17, the final sentence, approximately four lines up from the bottom:

> "To effectively carry out this role, particularly with regard to audit, the AE should remain independent of the operational structure of the healthcare organisation."

Is that your experience of being an authorising----

A Yes.

Q Why do you consider it important to remain independent of the healthcare organisation?

A The designated person, and indeed duty holder above the designated person, is the employer of the authorised person. Individuals can find it challenging to tell their boss that things aren't being done properly or that they need to spend significant financial sums or resources onto a scheme. The AE is there to provide independent advice and assessment. All we lose is the contract if we upset the designated person or duty holder, but we have a professional

responsibility to provide that independent assessment. The AP being an employee of the DP is in a more vulnerable position to deliver bad news.

Q At the very bottom of page 110, we see various boxes with a rough chart. So we've got the designated person, an appointed senior executive at board level with assigned responsibility for the service. Then, below that, we've got the authorising engineer who is an appointed independent professional engineer. Then next to that, you've got the trust senior operational manager, so that's described as the "informed client" or the "intelligent customer", do you see that? Then below that structure, you've got the authorised person, that's an appointed, qualified technical engineer, and then below that you've got the competent person described as assessed and qualified craftsperson. Is that right?

A Yep.

Q Is that a rough organisational chart that you're familiar with acting as an authorising engineer?

A Yes.

Q Is that where you would sit in the hierarchy, that you're part of the chain but independent from

anyone that's in the direct designated person, senior operational management, and authorised person?

A Yes, and in my opinion and indeed as reflected in this chart, the important element is that, as an AE, I have direct access to the designated person without going through myriad of trust senior operational managers, as indeed the AP does should it be necessary.

Q If we can now look on to Health Technical Memorandum 2025, so that's in bundle 2, document 3. So, bundle 2, document 3, at page 163. Is this the original Health Technical Memorandum that we saw set out at paragraph 9 of your statement which came in in the 1990s?

A Yes, it is one volume of four volumes that make up HTM 2025.

Q This is the more specific ventilation guidance that it talks about in the suite of guidance?

A Yes.

Q Look on to page 166, please. See in page 166, top right-hand corner: "This HTM was written…"? See that?

A Yeah.

Q It says: " This HTM was written with the advice and assistance of experts in the NHS and industry." See that?

A Yes.

B So again, was it your understanding that, really, from the 1990s onwards, there was a collaborative approach to producing this type of guidance?

A Yes.

Q We then look on to page 169. Do you see at paragraphs 1.4 and 1.5, so page 169, 1.4, it sets out what ventilation is:

> "'Ventilation' is provided in healthcare premises for the comfort of the occupants of buildings. More specialised ventilation will also provide comfort but its prime function will be to closely control the environment and air movement of the space that it serves in order to contain, control and reduce hazards to patients and staff from airborne contaminants."

Do you see that?

A Yeah.

Q Do you agree with that proposition?

A Yes.

Q It continues, 1.5:

> "Ventilation systems in themselves present little danger to patients or staff; however, they do possess the ability to transmit hazards arising from other

sources to large numbers of people. The danger may not become apparent until many patients and staff have been affected."

Do you see that?

A Yep.

Q Do you agree with that proposition?

A I do.

Q You can look on, please, to page 183. Do you see a heading called "Minimum fresh air requirements"?

A Yep.

Q Page 183, paragraph 3.15:

"For most applications involving human occupancy, the dilution of body odours is the critical factor in determining ventilation requirements; and where natural ventilation or full fresh-air systems are used, all ventilation air will be fresh."

Do you see that?

A Yep.

Q Then it continues:

"Where odour dilution is the overriding factor, it is recommended that 8 litres/second/person should be taken as the minimum ventilation rate; however, this rises to 32 litres/second/person for rooms with heavy smoking (CIBSE…"

Is that still the general guide just for any space, 8 litres per second per person?

A No.

Q How has that been updated?

A Building regulations currently specify a rate of 12 litres per second per person.

Q For any space----

A For any space, not healthcare specific.

Q -- minimum requirement?

A Education, industrial, office, anything you like, it's 12 litres per second per person.

Q That would be the base level. As you've said earlier today in your evidence, for specialist ventilation in healthcare, there might have to be more. At this stage in the----

A Apologies, John, could I just interrupt? Ten litres per second per person.

Q Ten litres per----

A I've got too many numbers rattling around my head at once, and building regs are currently under review which could change that figure again, but----

Q At this stage, and in terms of HTM 2025, do we find any

prescriptive table that sets out specific areas with specific air changes?

A Within the appendices of HTM 2025, particularly for operating theatres, air-change rates were specified. However, they were specified in terms of litres per second based upon a standard size of theatre, which equated to an air-change rate of 20 air changes. What was not specifically provided within HTM 2025 was an air-change rate irrespective of the size of an individual clinical space.

Q Why wasn't that done?

A I don't know. I was not involved at that point. I was still a junior engineer and wet behind the ears. It specifies, for a standard-sized theatre, the level of litres per second that's required in each space of an operating theatre. If you make that theatre smaller physically, then you actually get more air changes than would be essentially necessary. If you have a very large operating theatre space, you would have less air changes. I believe that is why, when 03-01 was updated in 2007, the move was made to air-change rates because air-change rates are not size specific in terms of flow-- airflow in a-- to a room, they are governed by the physical size of the room. Does that make sense?

Q Again, if I'm understanding you, from 2007 onwards, as opposed to just having a flowrate or a litre per second, there's a move to the concept of an air change per hour.

A Correct.

Q If we can look, please, within bundle 2, document 8, page 698. Bundle 2, document 8, page 698. Do you see here, it's "Heating and ventilation systems, Health Technical Memoranda 03-01: Specialised ventilation for healthcare premises" and it's "Part A: Design and validation". If we could look on, please, to page 702, which is the preface. Page 702, "About Health Technical Memoranda", it says:

> "Engineering Health Technical Memoranda (HTMs) give comprehensive advice and guidance on the design, installation and operation of specialised building and engineering technology…"

A Yep.

Q Again, would you agree that it's providing this comprehensive level of guidance for those in the industry?

A Yes and no. It provides guidance which I consider comprehensive on the principles as to

why we ventilate, what we're trying to achieve with ventilation; it does not, because it's impractical to do, provide specific guidance on every possible application where ventilation would be deployed. So the principles are comprehensive. Individual, specific guidance on "If your room's this big or that big, or you're going to do this or that different procedure" is not and cannot be comprehensive.

Q So still within the preface on page 702, just below the diagram, left-hand side, the paragraph:

> "Healthcare providers have a duty of care to ensure that appropriate engineering governance arrangements are in place and are managed effectively. The Engineering Heath Technical Memorandum series provides best practice engineering standards and policy to enable management of this duty of care."

Again, similar to what we saw in 2025, reference to best practice. If we look on to page 704, bottom left-hand corner:

> "Who should use this guidance? This document is aimed at healthcare management, design engineers, estate managers and the operations managers."

Again, that's consistent with what you've told the Inquiry. If we look on to page 705, you see a series of acknowledgements. So, we see the first person, Malcolm Thomas, I think you've told us about earlier who you described as lead author. What's Malcolm Thomas's background? Is he an engineer or is a----

A He's an engineer.

Q Then we see a range of principal contributors, we see a "Principal Clinical Scientist", individuals from industry, and then we see "Main Steering Group and Working Groups comprising representatives…", do you see that?

A Yep.

Q We've got the Department of Health, Welsh Health Estates, NHS in Scotland, Health & Social Services, Northern Ireland, a variety of bodies such as the Health Protection Agency(?). So, again, do we see bodies from throughout the United Kingdom having input into the Health (inaudible)?

A Yes.

Q If we look on, please, to page 712. In the introduction section, paragraph 1.7, the bottom left-hand corner. Page 712, paragraph 1.7:

> "The sophistication of

ventilation in healthcare premises is increasing. Patients and staff have a right to expect that it will be designed, installed, operated and maintained to standards that will enable it to fulfil its desired functions reliably and safely."

Then there's a whole reason-- reasons for ventilation, it says:

"The Building Regulations require that all enclosed workspaces be ventilated by either natural or mechanical means. The following are some of the factors that determine the ventilation requirements of a workspace: human habitation… activities of the department… dilution and control of airborne pathogenic material…"

Again, I think you've covered that in earlier in your evidence to the Inquiry today. You see "thermal comfort" and a whole range of other requirements set out there.

A Yeah.

Q You see at the bottom:

"Mechanical ventilation systems are expensive in terms of capital and running costs, and planning solutions should be sought which take advantage of natural ventilation, provided the above criteria are met."

Do you see that?

A Yeah.

Q Again, is that consistent with the evidence that you gave this morning whenever you said: "You should consider natural ventilation because it's cheaper, but there might be requirements for mechanical ventilation in certain areas"?

A Correct.

Q If you look on one page then, on page 713, do we see a table with ventilation? It gives some application examples. It's got the requirement, the reasons, and then the application that you'd have to consider for that. So for example, in the clinical space, really the reason for having ventilation is "reduction of surgical site infection" and "Source and protective isolation". So again, just to be clear, I think you covered this this morning. Just to be clear, what's meant there by "source and protective isolation"?

A It was when we were discussing either infectious or immunosuppressed immune-- neutropenic patients, so you are either isolating the patient from the surrounding environment or you are isolating in either direction, positive or negative; the environment can cause harm to the patient, or the patient could cause harm to others within the

general environment.

Q As we see in the right-hand box, applications would be "Isolation units for patients who present a biological, chemical or radiation harm to others" or "Isolation unit for patients with a reduced immune system." If we look on to page 716, please, bottom left-hand corner at paragraph 1.25 onwards. So we see a reference to specialised ventilation which states:

> "In healthcare premises, certain activities will necessitate the provision of ventilation equipment with additional special features in order to achieve and maintain specific conditions. These may be needed in order to assist with the treatment of patients or maintain the health and safety of staff. The precise reason for providing specialised ventilation will depend upon the intended application. The list below indicates some of the more typical reasons…"

We then see a range listed, including "a. to remove, contain or dilute specific contaminants or fumes", Do you see that? If we look on that page 719, please. On the left-hand side, you see a reference to natural ventilation. Paragraph 2.6 at the bottom, which states:

> "It is almost impossible to maintain consistent flow rates and ensure that minimum ventilation rates will be achieved at all times. However, this variability is normally acceptable in such areas as office accommodation, staff areas, library/seminar rooms and dining rooms, where opening windows (of a design that facilitates natural ventilation) should be provided."

Do you see that? There isn't any reference there to clinical spaces. Do you have any observations on that?

A Generally speaking, within clinical spaces, you have patients who either have specific issues or vulnerabilities which could be airborne, or you are undertaking clinical activity which could give rise to that. I would therefore believe that the HTM is suggesting natural ventilation is not ideal where there are specific ventilation rates required to achieve appropriate environment for healthcare, and if, within this document, you then refer back to Appendix 2, it will give you a list of those areas where specific ventilation rates should be achieved.

Q If we could then look on, still within the same document, to page

723, please. 723, top left-hand corner, paragraph 2.56, which states:

> "Natural ventilation is always the preferred solution for a space, provided that the quantity and quality of air required, and consistency of control to suit the requirements of the space, are achievable. If this is not the case, a mechanical ventilation system will be required."

Do you see that?

A Yeah.

Q So, in simple terms, is that the demarcation between (inaudible)?

A Yes.

Q If I could ask you to look on, please, to page 777.

THE CHAIR: Sorry, Mr MacGregor, that was my fault. That last reference was to page 777?

MR MACGREGOR: We're going on to look at page 777. The previous reference was-- I'll just go back but I think it was page 723.

THE CHAIR: 723? Thank you.

MR MACGREGOR: Yes, my Lord. It's page 723, paragraph 2.56.

THE CHAIR: Thank you.

MR MACGREGOR: I was moving on to look at 777. Lord Brodie, that may be an opportune moment to break. I'm conscious that's just before one o'clock.

THE CHAIR: Well, we'll take a break for lunch and sit again at two o'clock.

(Luncheon adjournment)

THE CHAIR: Good afternoon, Mr Poplett. Mr MacGregor.

MR MACGREGOR: Mr Poplett, before lunch, we were looking at HTM 03-01 from 2007, so bundle 2, document 8, and if I could ask you to please look at page 777. You can see that that is headed up, "Validation of specialised ventilation systems," and then on the left-hand side, we have got the concepts of "commissioning" and "validation". What is commissioning?

A Commissioning is the setting to work and, when it comes to ventilation, the balancing of the system to make sure that it functions as it should.

Q And then what is validation?

A Validation-- when you look at engineering services, they can all be commissioned in their own right. So a fire alarm system is commissioned to make sure that it does what it should do when it should do it. The ventilation system is

balanced and commissioned to make sure it does what it should do. Validation is a process where you ensure that all of those building services that interact with one another do so as they should do. So, in the example of fire alarm system and ventilation system, it's not unusual for a ventilation system to shut down in the event of a fire. However, in certain healthcare applications, such as isolation rooms where you're providing a protected environment or indeed operating theatres, you do not want the ventilation system to shut down as there could be a patient on the table in the middle of a procedure. As long as the smoke or the instrument that triggers the fire alarm isn't in the air duct supplying air to the theatre, the positive pressure cascade and the operation of the ventilation actually provides a relatively safe environment to be in in the event of a fire. It certainly gives the surgical team hopefully enough time to stabilise and secure the patient so they can be safely evacuated to a suitable location where care can continue to be provided. That may be the continuation of the operating procedure. So it's not as simple as saying, "Well, the fire alarm system works in isolation and the ventilation

system works in isolation." You need to make sure that they work together and don't create a problem or work in the strategy as it has been designed.

Q So, in terms of stages, you do the commissioning and then after that you do the validation?

A Correct.

Q Commissioning, making sure the individual components are working, then validation, making sure that all the components work together?

A Correct, and, for clarity, commissioning is often done as a direct result of or by the company who's done the installation. Validation should be done by an independent company to the installation.

Q At what stage would validation be done? So, in terms of a construction contract, would it be done before or after practical completion?

A In my experience, it is often offered before practical completion, normally successfully completed after practical completion. Validation, particularly for ventilation systems, should only be taken when all aspects of the construction have been completed.

Q So if we look on to page 778, please, and to paragraph 8.10, which states:

"In order to be successful,

the commissioning process must start before practical completion, as many parts of the system will become progressively less accessible."

Do you see that and do you agree with that?

A Yes.

Q It continues:

"The correct installation of those parts will need to be witnessed, and the leak-rate tests carried out as construction proceeds. Failure to establish responsibility for commissioning early enough will delay the completion of the project or lead to unsatisfactory plant performance."

Do you see that?

A Yes.

Q In relation to both commissioning and validation, what is the standard that the work is being checked against? Are we talking about the contractual specification or the Health Technical Memoranda and associated guidance or both?

A It should be both. It should be checked against the HTM, the design intent and the actual performance and contract.

Q What would you expect to happen at either the commissioning and/or the validation stage if there was non-compliance with a Health Technical Memoranda or a Health Building Note?

A I would expect that it be flagged up-- If it's at the commissioning stage, it should be by the installation or installer company who should either be able to confirm that that was a pre-agreed derogation or that it is a non-conformance or non-compliance. If it's at the validation stage by an independent validator, I would expect them to flag it as non-compliant but then refer it back for confirmation as to whether that was an agreed derogation or otherwise.

Q Thank you. If I could ask you to look on, still within the Health Technical Memorandum, to page 794, please. You can see here "Appendix 2 – Recommended air-change rates".

A Yes.

Q What do we see there?

A It is an appendix to the principal document which is intended to act as an aide-mémoire or a quick reference to the typical environmental conditions that would be identified typically within the ward areas or the clinical areas identified down the left-hand side.

Q Is this appendix new in this HTM 2025?

A Yes.

Q Why was it included? Why do we see things like a general ward and all of the areas there? Why are they listed in particular?

A I'm not able to answer that in full detail. I wasn't involved at that stage in production at 2007. However, my understanding is that its intent was to act as a quick-reference guide and endeavoured to amalgamate information from HBNs, which include information on ventilation, and HTMs, in this case HTM 2025, into a single point of reference. It was never intended to be the only page of the HTM that someone should read.

Q Was this general approach, this type of appendix, retained in terms of the HTM 2021 that you were involved in the creation of?

A It was retained and expanded in the latest version of the HTM. However, it was significantly supplemented by an entire new chapter within the current HTM 03-01 specifically highlighting which areas needed ventilation and why.

Q And do you know where the values that we see within this table, for example, for air changes per hour, where they come from?

A Not specifically.

Q Are you aware of there being any specific scientific papers or modelling that underpins the specific air change rates within this table?

A My understanding is that, where appropriate, they are derived from Lidwell's original research and some others are derived from other scientific sources, but they relate to control of pathogens. My understanding is that documentation is not generally within the public domain.

Q So why would it not be within the public domain?

A Because it contains highly sensitive and potentially dangerous information regarding pathogen and contamination levels.

Q Who would hold that information?

A My understanding is that it's controlled through Porton Down.

Q When you refer to "Porton Down", what do you mean?

A The chemical weapons research facility.

Q The UK government facility?

A Yes.

Q So, in relation to, if we just take, for example, critical care areas with 10 air changes an hour, why is the figure 10 as opposed to 12 or 8?

A Again, I don't have the specific scientific evidence base, but it is intended to represent a good rate of dilution to minimise potential infection transmission and risk.

Q In terms of the refresh that you did for HTM 2021, were all the figures within this table discussed by a range of individuals?

A Generally, yes. Some figures were amended and during the rewrite the-- Some of the figures were amended, but there is also, within the 2007 version, an in-use tolerance, which is-- which was 75 per cent of the stated figures were still deemed to be an acceptable level. So as a facility or as a system becomes older, if its performance drops off, then there was a tolerance built in against these figures which still left them as compliant and safe. Because some of the air change rates within the new HTM were lowered in a move towards supporting net carbon zero and carbon reduction, energy reduction, the percentage tolerance of in-use was, again, adjusted from 75 to 80 per cent with a minimum performance tolerance specified for, for example, operating theatres. So it, to a certain extent, became more complex. But if you were familiar with and understood the principles, it was more appropriate and

had slightly less of a safety margin, but still maintained safe performance.

Q If a facility complied with the principles set out in HTM 2025, would it comply with everything that is set out in each HTM 03-01, both 2007 and 2021?

A In terms of air flows and pressure regimes, yes. In terms of equipment and some efficiencies and equipment design, not necessarily.

Q In terms of flow rates and air changes per hour, why do you say it would still comply?

A Under 2025-- I'll use the operating theatre as the example because it's the easiest and most well understood. An operating theatre under HTM 2025 required 20 air changes and it had no tolerance for in-use degradation. So it should have done 20 air changes on day one, it should do 20 air changes the year after, the year after and the year after. Within 03-01 2007, the air change rate was increased to 25 air changes but with a 75 per cent tolerance allowance, which effectively reduced the minimum airflow rates down to 18.75 air changes. So the 07-- sorry, the 2007 standards for an operating theatre in use were lower than an operating theatre designed to 2025. Under 03-01 2021, we reduced the air flow rate

to 22 air changes but with an 80 per cent tolerance, however we specified a minimum air change rate within theatre of 18 air changes per hour. Therefore, a theatre designed to 2025 having 20 air changes should still be capable of complying to a theatre operated under 03-01 2021 at 18 air changes.

Q Thank you. In relation to the guidance that is set out within the Health Technical Memoranda, is compliance mandatory?

A No. It is not a legal requirement in and of itself. As I've discussed earlier, it is-- in my opinion, it should be taken as an approved code of practice. So compliance should be achieved or a soundly-based risk-assessed approach and mitigation provided as to why compliance isn't being achieved and, where appropriate, what alternate methods are being employed to counter the non-compliance.

Q What practical steps would you suggest required to be taken if you were going to derogate from a standard within the Health Technical Memoranda?

A The first thing is to outline exactly the scope of the derogation and the reason for requiring it. There are many legitimate and very sound reasons where a derogation

may be appropriate, particularly if you are working within the confines of an existing facility. Having established what is being derogated and the reason why, it needs to be assessed against what the implications of that derogation would be. Those implications need to be assessed and considered and decided on whether it should be adopted or not. If it is adopted, it should be fully documented and recorded not only on the project file during construction, but that derogation remains active for the life of that building. So as clinical function changes and develops, it's not only assessed against the original clinical function that it was being designed, but any future clinical function that it is then used for to ensure that the derogation is still safe and appropriate.

Q So, in relation to an existing facility that was perhaps being refurbished, are you indicating that there would have to be a risk assessment if you were going to derogate from the Health Technical Memoranda standards?

A Well, I believe there should be a risk assessment whether it's a new facility or an existing facility for a derogation.

Q Okay. Really, what I wanted to know is in relation to a new

facility, just starting with the specification on a blank sheet of paper for a completely new facility, would you be anticipating that there should be derogations from Health Technical Memoranda?

A I would like to think not, however a hospital does not exist within its setting in isolation. There are planning restrictions, there are physical constraints of site. There are all sorts of things which can impact full compliance.

Q In your view, are there certain aspects of the Health Technical Memoranda that simply should not be derogated from?

A My opinion is anything that directly could impact on patient or staff safety should never be derogated.

Q Because in paragraph 74 of your statements – that is on page 130 of bundle 6 – you say:

> "In all practical sense my belief and interpretation is that the HTMs should be viewed as an approved code of practice and as such should be deemed in elements as minimum standards."

Do you see that?

A Yes.

Q So when you are talking about minimum standards, is that the idea of patient and staff safety?

A Yes.

Q Then if we skip the next sentence, you go on in paragraph 74 to say:

> "It's not black and white and I believe that organisations who choose to derogate from HTMs have an increased risk of potentially compromising patient outcomes, staff/visitor safety in addition to increased risk of legal, civil and reputational damage/harm."

Do you see that?

A Yes.

Q So is that your view?

A Yes.

Q You go on at paragraph 75 in the second sentence to say:

> "… I wouldn't depart from any element that had a direct impact on patient, visitor or staff safety, which I would consider to be an absolute red line."

A Yes.

Q So is that essentially your position? There can be derogations, but there are certain issues that relate to patient and staff safety that you simply, in your view, could not derogate from?

A Correct.

Q In the period that Health Technical Memoranda 03-01, the 2007 version is in force, is there any standardised procedure for a derogation from the standards set out within the guidance?

A Not to the best of my knowledge.

Q So what happened in practice if a trust wanted to derogate from those standards?

A In my experience, it was, in well-run projects, discussed, debated, agreed and recorded on a project file. But, once agreed, it was generally not subject to re-review at any stage, either up to or including project completion or indeed operation.

Q In terms of a derogation, who would be approving the derogation? So if we think of a trust that is operating a hospital, do they simply self-certify that or do they have to ask for approval from government?

A Again, it varies, in my experience. Now, it would be passed through the Ventilation Safety Group, which is a new group introduced in the latest HTM. Historically, prior to the rewrite of the HTM, it would, in my experience, most probably be decided at a project team level with either the project director and, in the best circumstances, input from directors of

Infection Prevention and Control, other IPC team members and clinicians.

Q In the case of a contractor----

THE CHAIR: Sorry, I just got a little bit behind. Can we just take that last bit of evidence in relation to the current practice and the previous good practice?

MR MACGREGOR: Certainly. I think we will come on and deal with the Ventilation Safety Group, but I think you were outlining to the Inquiry your views on what should happen in terms of how a derogation should have taken place in the period up to HTM 2021.

A Yes.

Q So can you just explain to the Inquiry again what should have happened?

A In an ideal circumstance, where a derogation was sought under the 2007 standard, it should have been subject to multi-disciplinary review and discussion. Normally, it was held at a project level. At that project level, it should have included discussions and agreement from director level, director of Infection Prevention and Control, IPC teams and clinicians.

Q When you say “IPC”, you mean Infection Prevention and Control?

A Infection Prevention and

Control.

Q So, in short, not just engineers deciding to derogate from standards?

A Definitely not.

Q If there was a scenario whereby a new hospital was being built, so there was a construction contract in place and the contractor wanted to derogate from Health Technical Memorandum, would it be the client, the trust, that would be approving the derogation?

A Yes.

Q If that contract contained a specification that was not compliant with the Health Technical Memoranda guidelines and the contract permitted that, would you consider that there was a need for any formal derogation?

A Yes.

Q So just explain what should happen in that scenario.

A It should have still been recorded that, notwithstanding what the HTM stated, the contract had been based upon a design which required the following areas of non-compliance. So you still need to record what you aren't complying to and why.

Q What should happen if there was a conflict within the guidance in terms of if there were two standards and you could not comply with both? What would happen in that scenario?

A Then that discussion is where the multi-disciplinary group would discuss it, identify which standard was the most appropriate and comply with the one that was most appropriate, and record the fact that the other was derogated from because of that identified conflict.

Q Just thinking back to Appendix 2 that we have looked at, I think you mentioned that, in your view, that was general guidance that was being provided within that table. Would you agree that the question of whether or not a ward or a room in a hospital required any particular standard of air change rate would ultimately be a matter of clinical opinion?

A Clinical and IPC.

Q So clinical and Infection Prevention and Control. If I could ask you to look, please, to paragraph 87 of your statement, which is on page 135, you state there:

> "To summarise, you cannot derogate from minimum standards. If a ward or room is designed to do ten air changes and you have an eighty per cent tolerance within the current HTM, and it falls below eight air

changes, it's non-compliant and should be shut. The recommended air-change rates are the required standards to minimise the risk of adverse health impact patients and staff." Do you see that?

A Yes.

Q Would you accept that whether a ward or room should be shut in relation to any given air-change rate would be a matter of clinical opinion?

A Yes, and whilst that statement is correct, "It technically would be non-compliant and should be shut," if in discussion the risk to patients of closing the area was greater than the risk of operating it, then it would be derogated against. Equally, mitigation could be put in place to reduce the occupancy level, to maintain the ward open, reduce the number of occupants and the number of staff, therefore reducing the risk of aeromicrobiological contamination and accepting the lower rate of dilution.

Q So what would happen, for example, if the alternative accommodation was a Victorian hospital that may have poor air quality and infection control? What should happen in that situation?

A It would need looking at

and assessing on its merits at the time. A modern ward that only does-- if it was designed to do 10 and is only doing seven may still be better than a ward with no ventilation that's in a different historic hospital. It's not the age of the place, it's the airflow performance that's critical.

Q Thank you. Can I ask you, please, within bundle 2 to look to page 695, which is an article from the Health Estates Journal called "When to seek derogation, and the best approach"? Is that an article written by yourself?

A It is.

Q Why did you feel the need to write that article?

A It is a topic which is frequently debated and discussed at almost every NHS organisation that I've ever been involved with. I also have had numerous discussions with AEs not only within my own engineering disciplines, but other engineering disciplines, and we generally agree that the process for managing derogation is not as clear-cut as it could be. I therefore sought to highlight the issue within the journal and wrote the article, and subsequently have developed a derogation protocol which is currently under peer review by individuals who I

personally know, who-- with a view to adopting it as my company recommendation for how derogations should be managed.

Q Just so I am understanding you, in your view, there has been a lack of clarity historically about how one goes about the whole process of derogations and, in your view, there should be a standardised procedure to try to improve matters?

A I believe so, yes.

Q So if we just look within the article on page 695, left-hand side, just above the bold, "Legal", in the paragraph above that you state:

> "Debate over the status of all these documents can be highly contentious, and generally is not definitively defined. However, in my opinion, the following elements need to be considered …"

Do you see that?

A Yes.

Q So, really, a starting point about debate, about just exactly what standards the guidance have, what authority the guidance has. Then, in "Legal", approximately six lines up from bottom of the left-hand corner, you say:

> "The various Devolved Administrations agree that the documents produced are guidance documents. They become legal requirements when they form part of a contract, but the guidance documents are generally considered as an Approved Code of Practice, or – at the very least – good practice."

Again, is there some debate whether this is best practice or a good practice?

A Again, I believe that it depends upon the individual clauses as to whether they are classified or categorised as good practice, best practice or minimum standards.

Q Thank you. Then if we move on to page 696, you see in the bottom left-hand corner a bold heading, "Risk assessment". Do you see that?

A Yes.

Q Whereby you state:

> "While it is recognised that derogation is required in some cases, this must be risk-assessed, agreed, and documented, in order that it may be considered within the appraisal and approval process. Derogations must be properly authorised by the project's senior responsible owner, and informed

and supported by appropriate technical, Infection Prevention & Control (IPC), and clinical advice (irrespective of a project's internal or external approval processes)."

Do you see that?

A Yes.

Q Is that your personal view or is that an industry-wide accepted view?

A That is my personal view. The article was written specifically from my position. However, I think it is reflective, on feedback I've received from individuals prior to publication and indeed individuals since publication, that it is-- I am not unique in my opinion.

Q I now want to move on and ask you some further questions about HTM 03-01 2021, so the refresh that you were involved in. I think you have already told us that Malcolm Thomas was the lead author still of that document; is that correct?

A Correct.

Q In terms of the process, you have told us that there was broad input from a range of disciplines. Can you just remind us, what were those disciplines?

A They covered authorising engineers, professional institutes such as CIBSE, IHEEM, SVH Society, HSE- HSA UK now, or then PHE, Public Health England, manufacturers, verifiers, installers, air handling unit manufacturers. A wide range of individuals were both on the primary committee or steering group and it was also sent out, in its various draft formats, for detailed comment to professional institutes, societies and various Royal Societies for the various medical disciplines. Royal Colleges – I always forget that term.

Q You mentioned earlier in your evidence that one of the innovations within the new Health Technical Memorandum from 2021 was the creation of a Ventilation Safety Group.

A Yes.

Q Can you just explain what is a Ventilation Safety Group?

A A Ventilation Safety Group is intended as a multidisciplinary team and it is reflected by the same principles as laid down in HTM 04-01 for water HTM 06-01 for electrical safety, decontamination, medical gases. All of the HTMs have moved in recent versions to having this multidisciplinary approach where specific discussion can take place regarding that engineering discipline that it is responsible for both to insure and

provide assurance that the systems are operating and being maintained in an appropriate condition and any new projects that are planned are also taking due consideration of the influence of their respective engineering discipline – so, for the VSG, ventilation.

Q So the concept of a safety group had existed in other areas, as you've said, such as water and electricity, but it was simply being new in the sense that it was being introduced for ventilation now.

A Correct.

Q If I can ask you to look, please, within bundle 2 to document 5 at page 320, please. So, bundle 2, document 5, at page 320: "Health Technical Memoranda 03-01 Specialised ventilation for healthcare premises Part A: The concept, design, specification, installation and acceptance testing of healthcare ventilation systems." Is this the 2021 version?

A Yes, it is.

Q If we look to page 321, do you see a blue box at the bottom?

A Yep.

Q Which states:

> "This guidance is not mandatory (unless specifically stated). However, any departure/derogations from this HTM – including the measures implemented – should provide a degree of safety not less than that achieved by following the guidance set out in this HTM."

Do you see that?

A Yeah.

Q Why was that statement inserted?

A It was inserted because it highlighted the fact that, whilst not mandatory, we expect the guidance to be followed unless it is derogated and, in derogating, mitigation provided that provides equal or better compliance than the standard.

Q If we look over the page to page 322, please, in the bottom left-hand corner. Do you see reference to various statutory standards, plus technical standards and guidance, the Health Building Notes are mentioned, for example. Then it continues:

> "The need to demonstrate a robust process for agreeing any derogation from Technical Guidance is a core component of the business case assurance process."

Do you see that?

A Yeah.

Q Was that new or did that exist prior to 2021?

A It wasn't as explicit prior to this, so it is new from that perspective.

Q Were there business case assurance procedures before 2021?

A Yes.

Q It continues:

"The starting point for all NHS healthcare projects at project initiation document (PID) and/or Strategic Outline Case (SOC) stage is one of full compliance."

Do you see that? It continues:

"Derogations to standards will potentially jeopardise business case approval and will only be considered in exceptional circumstances. A schedule of derogations will be required for any project requiring any external business case approval and may be requested for those that have gone through an internal approvals process. While it is recognised that derogation is required in some cases, this must be risk-assessed and documented in order that it may be considered within the appraisal and approval process. Derogations must be properly authorised by the project's senior responsible owner and informed and supported by appropriate technical advice (irrespective of a project's internal or external approval processes)."

Do you see that?

A Yes.

Q So is that the innovation, really?

A Yes.

Q If we could then look on to page 347, please. So we see section 4.0, "The design and specification process". At 4.1, there's an analysis of the "project brief". What's the project brief?

A Project brief is basically what you want the facility to provide. So it could be as simple as, "Please provide four operating theatres and associated accommodation" or it could be, "Please provide a new district general hospital with the following clinical disciplines". As it develops, that will come into more detailed space in terms of numbers of bed spaces, numbers of facilities, range of facilities, and forms the basis of what would commonly be called an output specification, i.e. what we want to get at the end of the project.

Q Okay, and then do we see at paragraph 4.4 onwards there's a detailed analysis of the Ventilation

Safety Group?

A Yeah.

Q Does that really just set out in-- perhaps in some slightly more detail, the summary you've provided of what the Ventilation Safety Group is and what its purpose is?

A It does.

Q If we then look on to page 349, do we see now a specific section titled "Derogations and alternative design strategy"? So, page 349, paragraph 4.10:

> "Any derogations or alternative design strategies from this guidance should be subject to the scrutiny and agreement in writing by the VSG. The reason for the derogation or alternative design strategy and limits to its application should be recorded… Designers proposing a derogation or alternative strategy should be able to supply a body of evidence that their proposal will provide a degree of safety no less than if the guidance in this document had been followed."

Do you see that?

A Yeah.

Q So not simply stating "We're going to do something different", there has to be a body of evidence to support that. Then we see in the note, perhaps reading the final sentence:

> "There should be evidence that what is being proposed has been successful elsewhere."

Then if we look over the page onto page 350, top right-hand corner, paragraph 4.17:

> "New build healthcare facilities must be fully compliant with the requirements of all legislation in force at a date agreed when signing the contract. They should comply with the guidance contained in the current HTM unless a derogation has been agreed with the VSG…"

And then we see the reference back to the procedures for agreeing that derogation. Within this document, there's obviously reference to commissioning and validation. Had anything in substance changed in relation to commissioning and validation since the 2007 HTM?

A Yes.

Q What had changed?

A The level of detail contained in chapter 12 for the validation process has been articulated far more clearly, and there is specific reference to the different stages when witnessing or validation of the

installation should take place. It's also expanded the level of commissioning and validation testing that is required for ventilation systems such as leakage testing of ductwork.

Q So the same procedure, but a beefed-up specification of what has to be done.

A Same basic principle but far more detail and far more prescriptive.

Q If we could then look on, please, to Appendix 2 on page 482. Again, I think you'd mentioned previously in your evidence that there had been a slight change to this table from the 2007 version, but we still see, for example, a general ward has got six air changes per hour, critical care areas still have ten air changes per hour. So were there significant changes from 2007 to 2021?

A It depends on your definition of significant. As an example, operating theatres dropped from 25 down to 22 air changes per hour, but with the adjustment in the in-use tolerance as I've previously outlined. Endoscope treatment procedure rooms were changed from positive pressure to negative pressure cascades due to a reassessment of the risks associated with multidrug-resistant TB versus an interventional

clinical procedure. However, we also recognised the fact that, within endoscopy procedures, it is sedation that is used and not full anaesthesiology, therefore the air-change rates were dropped from 15 to 10 where sedation anaesthesiology was only used and not full anaesthesiology. If full anaesthesiology is used, 15 remains the correct levels.

Q In terms of the specific values in terms of air changes per hour and other values that we see in there, is your explanation as to why we find those various figures, is that the same as for HTM 03-01 2007, that it's a consensus view based on, as you understand it, a certain body of evidence?

A Yes.

Q Again, can you just explain exactly how this process came about in terms of the discussions amongst the multidisciplinary parties involved?

A Discussions took place. There were varying drivers and influencing factors, not least of which the need to – as far as practically and safely achievable – move towards net carbon zero, and you will see many of the changes between the 2001 and the '07 standards based around energy

and plant efficiency. So we need-- We still want the right amount of air, but we don't want as much safety margin or to over-engineer solutions which are extremely energy hungry. Ventilation is a huge user of energy and, as such, is a major contributor to the carbon footprint of the NHS. So, as far as reasonably practicable, where it did not impact patient safety, those levels were reduced to a safe standard but not an excessive standard.

Q Thank you. If I could ask you, please, to have your statement in front of you and to look to paragraph 56 on page 121, please. I want to ask you some questions about the development of a ventilation system. So, page 121, paragraph 56----

A 56.

Q You say:

"I have been asked if I have knowledge or experience in the key stages in the development of a hospital ventilation system. This something that I have been involved with throughout my career in different roles and stages…"

You see that?

A Yes.

Q So we've seen reference within the HTMs to a project brief. How does a project start in terms of the ventilation system?

A Once a clinical output spec has been established so we know what the facility is intended to do, a layout of rooms will normally be drawn up in a stage one feasibility design. From that point, an output specification for ventilation would be produced which would specify air-change rate, pressure cascades that we would expect in various classifications of the rooms identified being present within the design. That would be used as the basis of the design and plant layout and would be referred back to, to ensure at completion of design stage the ventilation performance was as per the output, provided that the clinical functions hadn't changed during that process.

Q So, if we take each of those stages, you said the first stage is a clinical output specification.

A Yes.

Q What would we see in a document called a clinical output specification?

A It very much depends upon the nature of the project. In its crudest forms it could be "provide a 30-bed respiratory ward facility" or "an expanded ICU facility". It needs to be what you actually clinically want to do

in that space. It could be multi-clinical function so, if it's a hospital, it will define each department that is going to be present within that space. From that, we can produce an output ventilation strategy or a performance specification which specifies, "For these areas, these are the air-change rates that we would expect to see; these are the pressure cascades, etc., etc." From that, the designer has the basis to move forward and undertake the design.

Q So, the clinical output specification, is that produced by the trust or is it produced by an external body?

A It's produced by the trust.

Q Okay, and then you mentioned the next stage being the layout of rooms. Again, would that be produced by the trust or by a body external to the trust?

A It's normally a combination of both. It's where the profession of healthcare planning comes in, and you need-- the clinicians know the patient flow and the patient pathway, you need to lay out the accommodation in such a way that it makes logical sense for the patient pathway through the service.

Q Then I've got you noted as saying that there was then a further output specification after that, is that correct?

A There is then the technical output specification for the ventilation which is produced based on, "If we're having this accommodation in this area, this is the ventilation that is required within those clinical spaces".

Q Would that be produced by the trust or would be produced by a body outside the trust?

A It would normally be produced by the trust with support from the AE or AP.

Q From the authorising engineer or the authorised person, but not necessarily with external input or would external input be required?

A Well, the AE is technically an external input. So it can involve M&E designers, it very much depends upon the design approach being adopted and whether the feasibility stage is covered by professional support, i.e. an M&E contractor or M&E design consultant and architect, which is often the case.

Q Then after that, you said there would be a more detailed design that would be built out from there.

A As the project progresses, you then get the more detailed design developed.

Q In terms of the discussion that we had earlier today, in terms of room data sheets, when would they be produced?

A The reality is that the room data sheets will be derived from the activity database at an early stage, but not refined or fully developed until detailed design has been normally completed.

Q Who would develop the room data sheets from the activity database? Would that be done by the trust, or would it be done by an external contractor?

A It would normally be done by an external consultant, but with close working and liaison with the trust.

Q If I could ask you to look within your statement, please, to paragraph 57. So, approximately just over halfway down, you use the term "ventilation strategy", do you see that?

A Yeah.

Q So you say: "This will assist in creating the ventilation strategy, which should be provided to the design team." Can you just explain what you mean by the ventilation strategy?

A It is the output performance specification for the ventilation system. It's identifying

which areas we want ventilated to what level.

Q So, again, just so I'm understanding you, the clinical output specification and then moving on to the technical output specification, just remind me, when do the room data sheets come in?

A The room data sheets come in once you've got a finalised layout of rooms, you then start populating individual room data sheets. The information to populate those room data sheets-- the framework comes from the activity database, which is then refined subject to what you've put into the ventilation strategy or ventilation output spec to refine the ventilation rates required room by room.

Q If there is going to be a derogation from the standards in the Health Technical Memorandum, at what stage in the development of the specification would you expect that to be identified?

A Derogations are typically identified at detailed design stage.

Q For 2021, would the authorising engineer have had a role in that derogation process?

A Technically, yes, they should have done. Yes, they should.

Q You say they should,

would that always have happened in practice?

A Well, the difficulty is that HTM 03-01 2007 was written before the role of AE was written, so it wasn't until 2014 that the 00 standard first identified the formal role of AE. So, between 2007 and 2014, technically there was no role of AE, so it would be difficult to say that they would always be involved. However, it should be that decisions of that nature affecting ventilation should have sought the advice and approval of those individuals now known as authorising engineers but also directors of infection prevention control and clinicians so they could assess the potential impact of any of those derogations. If it was a non-performance related derogation, such as the energy efficiency or air leakage rates, then that is more of a technical determination but it should still be discussed and agreed within the technical elements of what are now called the VSG.

Q Do you have experience in relation to reference designs?

A Some.

Q Can you just explain what experience do you have of reference designs?

A Reference designs are

generally a sharing of, "We've done this at this hospital, and it worked well. This is the standard by which you can operate this type of facility." They generally are obviously specific to the individual design that they relate to, and normally need some adaptation to fit the geographic location or service requirements of a particular hospital that is being designed.

Q Are you familiar with the differences between a reference design and an exemplar design?

A In broad terms, yes.

Q Is there a normal extent of detail that you'd expect to see within a reference design?

A There are levels of detail which I would expect to see at the various stages of design, but those stages can, depending upon how detailed they get, determine the level of detail that you get on ventilation layouts.

Q I appreciate it's difficult to be specific, but in terms of the volume of detail, on a sliding scale of one to ten, one being not very detailed, ten being extremely detailed, where would you expect that to land for a reference design?

A I would normally expect, within a reference design, to at least have the room performance

parameters detailed. I would not expect to see the level of detail of service sizing, service runs, but general-- where things are going to be located, primary plant areas, general room performances, I would expect to see.

Q In the period from when HTM 00 brought in the concept of an authorising engineer, would the authorising engineer have had a role at the time of the development of a reference design?

A Again, ideally, I would expect so, yes.

Q Okay, and what would you expect that role to be?

A Similar to the production of a ventilation strategy or output performance specification.

Q During the course of the development of a reference design which did contain detail of relative pressurisation of individual rooms or wards, would you expect a health board or its design advisors to identify and seek a derogation in respect of any departure from relevant ventilation standards in HTM 03-01?

A It would very much determine on what the derogation-- extent of derogation was and the impact of it; if it was an infectious disease unit, most definitely yes; if it

was a general ward area, possibly not.

Q In your opinion----

THE CHAIR: Sorry, Mr MacGregor, could I just have the proposition? I'm sure it's entirely my fault. We're talking about a hypothetical reference design----

MR MACGREGOR: Indeed.

THE CHAIR: -- and that hypothetical reference design includes how much-- are you supposing it includes information about air changes and pressure or not necessarily?

MR MACGREGOR: Which did contain detail of relative pressurisation of individual rooms or wards.

THE CHAIR: Right. Okay, could I ask-- Now that I've got the proposition more firmly in my head, could I ask you to put it to the witness?

MR MACGREGOR: Certainly, I'll ask the question again. (To the witness) So, during the course of the development of a reference design which did contain detail of relative pressurisation of individual rooms or wards, would you expect the health board or its design advisors to identify and seek a derogation in respect of any departure from relevant ventilation standards such as in HTM or 03-01?

A I would expect it to be highlighted that it was a deemed variation to that standard and, if it was

of sufficient impact to warrant a derogation, then yes, it should be formally sought and recorded.

Q Should a reference design dealing with the ventilation requirements of clinical rooms or wards be approved by clinicians or infection control specialists before it's issued for tender, in your view?

A Yes.

Q Thank you, Mr Poplett, that concludes all the questions I have for you at the moment.

Lord Brodie, that concludes all the questions I would wish. There have been discussions between myself and core participants' counsel to try to avoid any formal rule 9 applications. Your Lordship may wish to check whether there's any additional issues that counsel for core participants would wish to raise.

THE CHAIR: Before I do that, Mr Poplett, are you the person or are you a person to ask about how activity databases are used in practice? We've touched on them, and I've got a sort of high-level understanding of how the activity database is a source of information from which I assume architects, maybe others as well, can derive information which can then be expressed in room data sheets, but I have to say I don't quite understand

how that process is carried out in practice. This may not be your particular sphere of expertise.

A It isn't, but my understanding of the process, having been through it on a fair few occasions, is that the clinical output spec will identify-- and I will use a single example of a treatment room. From the activity database there is a, if you like, library of "these are the typical performance parameters, engineering services, space requirements, fixtures and fittings that we would expect to find in a treatment room". That would be transferred from the ADB into a room data sheet for the treatment room under development. It would then be adjusted or tweaked to suit the specific requirements of the clinical treatment that is planned for that space. So, if it was that they were going to be doing endoscopy or fluoroscopy examinations within it, it moves from a treatment space specifically to a specific endoscopy treatment room space, and that is within the RDS where it is, if you like, tweaked and personalised to the specific requirements for that room in that project.

Q Is the RDS expressed as a series of outputs or is it expressed as an architect's drawing?

A In practice, it is both. There is normally an architect's drawing and, at that stage, it is typically at a 1 to 50 scale, so it's quite detailed in terms of the contents. The RDS will also include the environmental conditions, lighting levels, ventilation levels, water provision, but it will also typically include details of furniture, fixings, and equipment that would be provided as part of the scheme. So soap dispensers, mirrors, etc. can be detailed to that level of detail within an RDS; what they tend not to show, although they can, and it's particularly prevalent within the EFI schemes, is loose equipment. So equipment is categorised as either group one, two, three, or four. Group one equipment is fixed within the structure and is always listed within the RDSs. Group two is fixed, but loose equipment, so a washing machine; if you pick the room up and shook it, it wouldn't fall out because it's plumbed in; group three, which is loose equipment, wastepaper baskets, desks, chairs; group four, which is technical IT equipment. So, basically, an RDS can be as detailed as you want it to be, but you use the activity database as the framework but adjust it to suit the particular requirements of your design or clinical requirement, and you add the necessary detail in terms of services, performance, and – if you go to that level of detail – fixtures and fittings that the room would be expected to have.

Q If I followed that, that supposes that there are a number of generally agreed descriptors for rooms. You used the example of a treatment room. So the activity database is accessed through a given number of generally agreed descriptors of particular rooms that you would expect, or particular spaces you would expect to find within a healthcare facility?

A That is my understanding.

Q Thank you, that takes me a bit along the road. Now, Mr McGregor anticipated that there would be nothing arising out of his questioning. Was he right about that? Well, I'll take that as an affirmation. Thank you very much, Mr Poplett, for your evidence. We will now be rising, so we'll all rise together. We're not sitting tomorrow, as I understand it, but on Thursday we will sit again at ten o'clock. I think maybe on Friday we may be sitting a little earlier, but as far as Thursday is concerned, I look forward to see the legal representatives at ten o'clock on

Thursday. Thank you again, Mr Poplett.

(The witness withdrew)

15:10

(Session ends)