SCOTTISH HOSPITALS INQUIRY

Witness Statement of

Michael O'Donnell

Professional background

1. I am Michael O'Donnell. My address for the purposes of this inquiry is c/o Hulley and Kirkwood, The Stack, Papermill Wynd, Edinburgh, EH7 4QL. I have been a qualified Engineer since 1988, having graduated from Strathclyde University with an Honours degree in Mechanical Engineering. Following this I commenced employment with Blyth and Blyth consulting engineers as a graduate engineer, where I remained for a year until joining Hulley and Kirkwood in 1989. I have been a Chartered Engineer and a full member MCIBSE since 2007.

2. I am now Company Director at Hulley and Kirkwood and also an owner/shareholder of the business. During my time at Hulley and Kirkwood I have been involved in a number of projects within the construction industry, working in most sectors such as education, commercial and residential , infrastructure and healthcare. This included Hull Oncology(Queen's centre for Oncology and Haematology) and the original Edinburgh Royal Infirmary, which was one of the first Scottish PFI hospitals, Victoria Hospital in Kirkcaldy, technical advisers to NHS Orkney and work at the Western General Hospital.

Overview

3. In this statement I will address the undernoted themes: -

a. Hulley & Kirkwood's appointment as M & E Design Consultant (2009-2010)
b. Hulley & Kirkwood's appointment as M & E Consultant (2011-2012)

c. The Environmental Matrix
d. The Thermal Comfort Analysis/Reports
e. Responses to Rule 8 request dated September 2021

Hulley & Kirkwood's appointment as M & E Design Consultant (2009-2010)

4. In 2009 Hulley and Kirkwood were employed as Mechanical and Electrical Consultant (M&E) via the Healthcare Frameworks Scotland 2 procurement programme in support of the Royal Hospital for Children and Young Persons (RHCYP) new build. At this time the project was to be capital funded. Hulley and Kirkwood were to act as consultants within the supply chain of BAM construction who were the design and build (D and B) contractors and appointed to deliver the project at that time.

5. Due to it being a capital funded project it wasn't constrained to a set of Reference Design deliverables at that time. Hulley and Kirkwood were working their way through the design in order for the contractor BAM to price it and agree the contract and then commence building. We had probably reached Concept Design RIBA Stage 2 and were involved in market testing various packages to assist in costs planning at that time. This had resulted in a number of reports, documents and deliverables being produced to help progress the design.

6. On 14 December 2009, a Design Team Meeting was held by BAM Construction, which I attended. At this meeting it was confirmed that the DCN Reprovision would not be delivered as part of a joint build with the new RHSC at Little France. Internal summary notes from the meeting set out the focus for the design on the RHSC only project going forward. Nightingale Architects were also in attendance. They advised that ADB files from NHS Lothian had been through the user review process already, that these would be issued to facilitate Codebook, that Environmental Data would be generic, and that Hulley and Kirkwood were to develop a bespoke Environmental Matrix to take over from the information contained in the ADB sheets. This was our first instruction to produce an Environmental Matrix spreadsheet.

7. In 2010 the project was halted and would move to Non-Profit Distribution model of funding rather than capital.

Hulley & Kirkwood's appointment as M & E Consultant (2011-2012)

8. In 2011 Hulley & Kirkwood were re-engaged as M&E Consultant by the client NHS Lothian through Davis Langdon LLP, who were design team and project managers, Mott McDonald, who were project technical advisors. It was a chain that started with NHS Lothian, Mott McDonald, Davis Langdon and then the Design Team of which we were one of the Design Team Members involved in aiming to deliver reference design outputs. Our role would be to support the RHCYP and DCN Reference Design and to provide mechanical and electrical services conceptual design input. These contributions centred around M&E Plant & Riser strategy input, Building Research Establishment Environmental Assessment Method (BREEAM) Pre Assessment scoring input, creation of a Reference Design, Room Data Sheets, Environmental Matrix, Section 6 Building Regs Compliance Report, Ward Bedroom Daylight and Thermal Comfort Analysis/Reports. There were tasks defined within the appointment; a list of reference design deliverables. We were contacted to re-engage in the project via an e-mail dated 14 April 2011 from Fraser McQuarrie of Davis Langdon.

9. During this period Hulley and Kirkwood would work alongside other partners involved in the Reference Design, which included Nightingale Associates (Architects), BMJ (Clinical Architect), Arup (Civil & Structural Engineer/Fire Strategy/Acoustics), Thomson Gray (Technical Advisers) and Turner Townsend (CDM Co-ordinator). The process of the programme involved developing information so it could be shared, reviewed, revised and taken forward. This was typically channelled through Davis Langdon who would share with Mott MacDonald and other client groups.

10. I do not recall any significant deviations from the reference design deliverables, other than being advised by David Langdon via email on 19 Jan 2012 that a decision had been taken by the PME to instruct Nightingale Associates to cease the production of room data sheets and that the room data sheets would now be produced by MML. Hulley & Kirkwood were still expected to complete the environmental matrix and the matrix still needed to go through the NHSL comment process which from start to finish takes about 4 weeks and that the matrix was needed by the end of January for this

process. Other changes that occurred were to the schedule of accommodation information, which meant that information that had been produced needed to be revised and reissued. If there was anything outwith the scope of the reference design deliverables, we would receive a change control instruction. We would be asked to assess the impact of it and put a fee proposal against it; that would then go up the hierarchy to Mott MacDonald to liaise with the client to decide whether or not that was instructed.

The Environmental Matrix

11. I have been asked by the Inquiry to provide some insight into the use and implementation of the Environmental Matrix (EM) during the project. For most health project that Hulley and Kirkwood have been involved in the Environmental Matrix has been used as a standard reference briefing document. This document aids the design briefing process and the referencing of information against the schedule of accommodation, which assists in dialogue with client and other stakeholders. The EM is populated with data from HTM/SHTM/HBN principally, depending on type of accommodation or department and used for the purposes of mechanical and electrical services. The data is input manually. It is not pre-populated using a computer software programme. I have been asked by the Inquiry to explain the purpose of an environmental matrix and explain the difference between this and room data sheets. On the original HK RHSC EM Guidance Note 1, it sets out the purpose of the EM i.e. " This workbook is to promote discussion and feedback to develop an Agreed Workbook by FBC sign off date and is intended as an easier reference tool to replace ADB RDS M&E Sheets for elements described on these sheets". On the subsequent HK Reference Design EM, Guidance Note 1 was revised to " This workbook is prepared for the *Reference Design Stage* as an easier reference tool to replace ADB RDS M&E Sheets for the Environmental Criteria elements as described on these sheets". ADB Room Data Sheets cover briefing information for individual room design character information (walls/floor,ceiling, windows, glazing, hatches) and Schedule of Components by Room (fixtures , fittings , equipment, sockets etc) as well as M&E Environment Room Data. An EM attempts to abstract relevant Environmental Data per room on a Departmental basis using the SoA listed room names to provide an easier reference tool for review and sense checking by appropriate end user groups. It does

not intend to take the place of the full content of ADB Room Data Sheets. ADB sheets cover all aspects of room briefing whilst an EM only attempts to cover relevant Environmental Data in a concise manner.

12. I have been asked by the Inquiry to address whether CEL19 (2010) **(A37215536 – CEL 2010 – Letter to Chief Executives, 'A Policy on Design Assurance for NHSScotland 2010 Revision' (2) dated 2 June 2010)**[1] had been drawn to our attention, would the Environmental Matrix have been produced. My thoughts are that if ADB RDS sheets (including Room Data M&E/Environmental Sheets) were to be produced and actually customised through consultation with clinicians and other stakeholders to suit individual department requirements for the project as part of client briefing information, there would have been no need for the development of an Environmental Matrix. However, I would also note that the new SHTN 02-01 from Oct 2021: Sustainable Design and Construction (SDaC) Guide requires the use of an EM and states with regards Environmental Matrix " It is expected that 'sense checking' with appropriate end user groups (including HFS/FM/Estate Management representatives) will commence at an early stage and continue throughout all project delivery stages."

13. I have been asked to clarify the sequencing of what comes first, the EM or RDS? There is no defined procedure for this as far as I am aware. Ideally, ADB RDS sheets reviewed by clinical leads would be provided as client briefing information at the start of any healthcare project and go through a review, consultation and customisation process throughout all project delivery stages as is now described for an EM in SHTN 02-01. Perhaps because an EM is a more manageable tool to journey through a review and consultation process across design stages, once the process has been concluded and agreed, then ADB M&E RDS sheets could be produced to align.

14. For the RHCYP only build in 2009-2010, the first EM was produced by us 9th September 2010 **(A34691163 – Environmental Matrix Version 1 issued in September 2010)**[2] to aid the design briefing process and to aid the referencing of that information against the schedule of accommodation. It was also to aid dialogue

[1] Bundle 1 – Published Guidance, Item 6, Page 553
[2] Bundle 4 – Environmental Matrix, Item 3, Page 42

with the client, essentially, to see what information within it is agreed. The review process was channelled through BAM onto a project intranet called BIW Information Share. The BAM project managers would encourage stakeholders and parties (which included clinicians) to review the matrix. However, no formal comments were received back through this process. It was our experience that the clinical specialists only get to go through this process once or twice in their careers. It is not as though they get involved in the briefing of a new major project routinely, and so they have a difficult challenge to (a) carve out the time to understand that it is quite an important process to get their input on, and (b) get their own mindset clear to actually engage, to address things that need to be addressed. The impetus to provide the second matrix issued 22nd December 2010 **(A34691173 – Environmental Matrix Version 2 issued on 22 December 2010)**[3] was the schedule of area update, version 8.

15. The HK Reference Design Stage Environmental Matrix was first issued 3rd February 2012 **(A34691181 – Reference Design Envisaged Solution – RHSC/DCN RDS Environmental Matrix – 3 February 2012)**[4] , second Issue 13th March 2012 **(A34691183 - Reference Design Envisaged Solution – RHSC/DCN RDS Environmental Matrix – 13 March 2012)**[5] and third Issue 19th September 2012 **(A34691184 - Reference Design Envisaged Solution – RHSC/DCN RDS Environmental Matrix – 19 September 2202012)**[6] and prepared by Jonathan McMillan, currently HK Associate but design engineer at time of drafting documents. His qualifications at that time were, M Eng (Hons) Mechanical Engineering from University of Edinburgh, BRE Approved Certifier of Design for Section 6 Compliance, Integrated Environmental Solutions (IES) accreditation covering Section 6 Compliance for building types 3, 4 & 5 and for preparation of Energy Performance Certificates, BRE ISBEM software qualification, CIBSE Low Carbon Consultant Simulation Specialist, CIBSE Low Carbon Consultant Building Design Specialist and Licensed BREEAM Assessor – Health Care. The Matrix was produced on an excel spreadsheet.

16. Jonathan McMillan and I came up with the concept of the room function reference sheet. It was an abstract summary highlighting all room types referenced in

[3] Bundle 4 – Environmental Matrix, Item 4, Page 60
[4] Bundle 4 – Environmental Matrix, Item 5, Page 77
[5] Bundle 4 – Environmental Matrix, Item 6, Page 103
[6] Bundle 4 – Environmental Matrix, Item 7, Page 131

the SoA and produced key criteria relevant to the room type. It had guidance notes. It was set out as a table and then there was an entry for the room function in each of the entries of the EM. We were trying to improve the EM and make it an easier document for parties to get a bigger picture of the common repeatable rooms. So you might have 15, 16, 20 room types throughout different departments. It is just trying to pull it together, bring it back to one and produce key criteria that's relevant to that room type. It listed the correct air change rates for HDU. The room function reference sheet was put in place as a result of us receiving no feedback – and that includes no clinical feedback - regarding the EM during the original project. I have been asked to clarify on who decided what room function was prescribed to a specific room. This was prescribed by HK during the creation of the RHSC DCN Environmental Matrix and the development of the Room Function Reference Sheet. I have been asked to confirm if nobody from the Board provided input on the specific room function. There was no input from the Board.

17. The purpose of the Environmental Matrix was that it was intended to provide an easier Reference Design "Envisaged Solution" reference tool, relating to the Reference Design Schedule of Accommodation to help summarise proposed environmental criteria, whilst referring back to relevant SHTM/HTM/HBN guidance. It was Hulley and Kirkwood's view that the Reference Design Environmental Matrix Envisaged Solution was not intended to be prescriptive for every design and that the eventual Preferred Bidder would be responsible for their own project specific Environmental Matrix, aligned to their specific building design approach within the constraints of relevant guidance and project briefing. Attached to the EM were Guidance Notes, which were provided to add context to relevant important SHTM/HTM/HBN guidance. Every page of the matrix cross refers back to the Guidance Notes for reference so they would be read and understood together and therefore the Guidance Notes provided an overarching status and relevance in relation to the information contained within the Department Sheets.

18. Beyond the Reference Design and upon selection of a preferred bidder design concept, the detail design process up to financial close would involve the creation, review, development and agreement of a new project specific Environmental Matrix. This would be aligned to the actual building design proposals and any relevant guidance current during that period. It would normally involve a review process where

any discrepancies and anomalies can be purified during the course of detail design development and on completion of design, before procurement, installation, testing and commissioning proceeds.

19. I have been asked if Hulley & Kirkwood were told at the time that "Beyond the Reference Design and upon selection of a preferred bidder design concept, the detail design process up to financial close would involve the creation, review, development and agreement of a new project specific Environmental Matrix". No-one specifically told us this as far as I recall, however given that the Reference Design was only an Envisaged Approach taken to the equivalent of RIBA Stage C Concept Design and that there was no specific architectural elevational design treatment provided by the Architect during the Reference Design, it follows that a new EM would be required that related to the preferred bidders actual design proposals. On the HK Reference Design Stage EM, Guidance Note 1 explains it is for the Reference Design Stage. In addition, Guidance Note 5 of the EM also states " ventilation air change rates and the use of natural ventilation in Patient Areas shall be reviewed throughout the detail design process…". In the Reference Design Thermal Comfort Analysis Report **(A34225373 – Hulley & Kirkwood Thermal Comfort Analysis Report – February 2012)**[7] we explained that the envisaged approach is not intended to be prescriptive and that alternative approaches where put forward beyond the Reference Design could also be valid. Finally the RHSC DCN M&E reference Design Approach Report within Section 3.0 Encode Checklist , lists under Follow Up Actions all aspects where the successful bidder actual solutions beyond the Reference Design should be reviewed, including Ventilation approach.

20. The EM subsequently replaced the M&E parts of the Activity Database (ADB) sheets, which were being produced by Nightingales, (architect) during the course of the Reference Design. These documents are prepared by architects / healthcare planners and drafted with information from the ADB database. The software package pre-populates the room data sheets with environmental information. Codebook is an extension of the ADB database. It does not produce automatically correct information. It has to be reviewed in the same way as the EM has to be reviewed and purified.
I have been asked to clarify if it was the intention that the EM and RDS would be

[7] Bundle 4 – Environmental Matrix, Item 19, Page 283

agreed documents or were they to be RDD? HK viewed the Reference Design Stage EM as an Envisaged approach for the Reference Design Stage. This was not intended to be prescriptive and that alternative approaches beyond the Reference Design could also be valid. This is mentioned in our Ward Bedrooms Thermal Comfort Report and intimated in our M&E Reference Design Approach Paper Encode Checklist. This would therefore require the preferred bidders design specific EM to be produced relative to their actual design proposals (including actual elevation proposals and natural ventilation proposals). We would have expected normal due process being that this EM or subsequent ADB RDS would follow through an RDD process.

21. The ADB sheets had been part of the original deliverables in the Reference Design but Nightingales had been advised to stop producing these but Hulley & Kirkwood were still expected to complete the environmental matrix . The ADB M&E sheets should align with the EM but the notion that ADB sheets can be reviewed concisely by lots of different parties in a co-ordinated fashion is both very difficult and impractical. Having a consolidated EM of information, with focus on elements of room data sheets from a Mechanical and Electrical design perspective, is a very useful tool to co-ordinate and agree what room type should have against the criteria stipulated by HTM/SHTM/HBN. The EM does not necessarily capture all the information that may be contained within ADB sheets, however seeks to capture key principal components such as temperature criteria, air change rates and other parameters relating to ventilation.

22. I have been asked if it is my position that the RDS should align with the EM. My view is if both were to be provided they should eventually align. In the event of any discrepancy where both RDS and EM exist, there would need to be a process to discuss the discrepancy, review both documents against relevant guidance whilst also sense checking with end user groups to arrive at an agreed alignment. Ultimately they should align. A review procedure of sense checking with stakeholders, clinicians and appropriate end user groups commencing at an early stage and to continue throughout all project delivery stages would be necessary to deal with discrepancies.

23. The fundamental piece of information that you need to start the EM is the schedule of accommodation. The architect provides this, and there is also a healthcare planner. They worked together. We got the schedule of areas; a

spreadsheet of the summary of the departments; the net internal area, the gross internal area; the total area of the hospital. For every department that has its net internal and gross internal area, behind that there is a spreadsheet for that department, with every room in that department, and that will list the room's briefed target area. It might also – if there's layout drawings that support the design by the architect – compare the briefed target area versus the actual drawn area. We take that information – the departments, room names, net internal area – and then patch in the key environmental data for each room across that. On top of that, we do our guidance notes where we try to list and highlight issues that stakeholders need to be aware of. For example, where there's contradictory guidance or where there's briefing that deviates from the guidance (such as the 25 degree stipulation for ward bedroom maximum internal temperature versus 28 degree maximum in guidance), or just simple nuances between SHTM and HTM. The guidance notes are there to support the key principle elements of design nuances, and then we run through the department sheets for every room and every department. The default position is to stick with the guidance unless we are told otherwise. I have been asked to explain how a specific room function sheet is determined. The room function reference sheet within the HK EM is a summary of repeating room types summarised from the SoA. Determining the room function was a judgement made by the engineer in the development of the EM.

24. It is our experience that the outputs from ADB sheets in terms of environmental criteria were often inaccurate or incomplete, which is why I think the EM became the main source for environmental data for the Reference Design. There can often be confusion in regards the use of a room within a healthcare setting (for example, whether a room is a regular examination/consulting room or whether it's a treatment room), as it's the application (or function) of the room which will define the ventilation for it. This then needs to be abstracted to create the ADB room sheets and define the environmental criteria for the room, ADB sheets are usually 4 pages of data for that room. So if we look at a large acute hospital with hundreds of rooms and numerous departments ADB room sheets can generate thousands of pages, which are cumbersome to manage and review. The EM generates less and is more consolidated with more focus on environmental information and is easier to control and review. One has to unravel SHTM and HTM requirements along with client specific instructions, such as the maximum ward room temperature of 25 degrees, which was a deviation from the standard 28 degrees maximum within guidance for general ward bedrooms.

I have been asked to explain why in my experience the outputs from ADB sheets in terms of environmental criteria are inaccurate or incomplete. In my experience, the ADB software is used by healthcare architects and health planners to assist in developing the clients briefing information. In my view, incomplete data outputs are typically because room data sheets are developed for key and generic rooms and then customised through consultation with clinicians to suit individual departmental requirements and this process requires time to arrange input from a number of stakeholders which is not always available when required. Example areas of confusion often arise whether a room is a Treatment Room or a Consulting/Exam Room, whether a Treatment Bay should be considered a Treatment Room, whether a Triage Hub is a Treatment Room, whether a Ward Isolation Room is supply vent only or supply and extract vent to achieve the required pressure, or has a PPVL approach. In addition, a general ward room can for example be provided with a natural or mechanical ventilation solution, or both (i.e mixed mode). A client may decide to deviate from guidance on maximum temperature criteria. The implications and outcomes of this is usually determined through simulation modelling which requires design development time to engage various design disciplines to determine what might be possible for any ward room on any given orientation and this design development may evolve over a number of design stages. So it therefore follows that unless the results of such studies are known and agreed and consultation takes place before the generation of ADB M&E sheets to make sure the room listing is correct, the listing for the Environmental Approach in certain rooms may be in doubt until discussions take place, solutions developed ,discussed and agreed which then defines the need for an iterative review process of ADB M&E sheets or EM (or both) across the design development stages.

25. I have been asked by the Inquiry if I agree with the expert, Professor Maddocks witness testimony that ADB RD sheets are best practice, as opposed to an EM. From my experience on the projects that I have worked on, ADB sheets need to be purified. I think it is best practice if they are correct, but they are not, by default, always correct. See also paragraph 20. Also note that the original RHSC and DCN NHSL Design Brief dated 10 June 2011 in Clause 4.11 Design Guidance recognises this where it states " room data sheets are developed for key and generic rooms and then customised through consultation with clinicians to suit individual departmental requirements."
I have been asked if I would expect the EM to be superseded by the point at which a

contract is concluded, with RDS for all spaces having been completed. My view is if by the point at which a contract is concluded ADB Room Data Sheets for all spaces had been completed i.e. customised through consultation with clinicians and other stakeholders to suit individual room and departmental requirements and sense checked and agreed, then it would be sensible at this point for the EM to be superseded.

26. I have been asked if HK had knowledge of the use of Room Data Sheets (RDS) during design process, however I have no knowledge of the use of these during the Reference Design other than being advised by David Langdon via email on 19 Jan 2012 that a decision had been taken by the PME to instruct Nightingale Associates to cease the production of room data sheets and that the room data sheets would now be produced by MML. Hulley & Kirkwood were still expected to complete the environmental matrix and the matrix would need to go through the NHSL comment process which from start to finish takes about 4 weeks and that the matrix was needed by the end of January for this process.

27. Matrices are reviewed by clinician user stage leads who engage with the architects regarding the use and arrangements of the rooms. These leads help to inform the brief for the architect. Estates teams are also involved as are facilities management. It is my understanding that reviews of the EM were undertaken by NHSL Estates. The First Issue was reviewed by them with comments received via email 07/03/2012 (I shall provide the e-mail to the Inquiry). The Second Issue was revised to align with SoA 10 as well as NHSL Estates comments as noted in the revisions notes of the EM. The Third Issue was further revised to align with a later SoA 13, which arose after the Reference Design deliverables had been completed.

28. At the RHCYP/DCN Reference Design stage, the EM of 3 February 2012 (within Page 5, Dept Code B1 for Critical Care/HDU/Neonatal Surgery Department Sheet) had the “Room Function” association assigned within the spreadsheet from the Accommodation SoA room definitions of “Open Plan Bay (4 beds)” to align with the generic “Multi-bed Wards” data. This unintentionally attributed the 4 ac/hr supply condition for this department, creating the discrepancy with the Guidance Notes listed as 10 ac/hr. There was however a cross reference to “See Guidance Notes” within the Notes Column of the Department sheet, which should have highlighted the anomaly

of the listed 4 ac/hr relative to overarching Guidance Note 15 and the stated need for 10 ac/hr, specifically for HDU bed areas/Critical Care areas. I have been asked to explain why critical care values were not ascribed and why HDU was not ascribed as a room function. Critical Care was not a room name in the SoA, however HDU was a room name in the SoA and therefore HDU was ascribed as a room function on the Room Function Reference Sheet.

29. I have been asked why the EM for RHCYP/DCN stipulated that the mechanical ventilation system for critical care multi-bed rooms would deliver 4 air changes per hour despite SHTM 03-01 guidance, which sets out 10 air changes per hour. This was not a derogation from the SHTM 03-01 guidance but a discrepancy, an error. Jonathan McMillan compiled the EM. He reported to me and I signed off on the EM to be sent to the architects after it had been finalised. I cannot answer why other parties did not spot the error, but I think that the cover guidance notes and room function reference sheet probably gave a reassurance to anyone upon initial view that the important parts of the guidance are captured, resulting in no actual digging into the individual cells per room on the departmental sheets.

30. I have been asked to confirm if the discrepancy/error was simply a manual transcription error. This was a manual transcription error creating a discrepancy with correct information referred to within the matrix guidance notes and correct information on the HDU Room Function Sheet listing. The HDU transcription discrepancy was not intended and therefore not listed as a derogation. The general ward bedrooms mixed mode ventilation approach is a valid approach described in HTM 03-01 from 2007 and SHTM 03-01 from 2011 **(A33662241 – Scottish Health Technical Memorandum 03-01, Ventilation for healthcare premises Part B Operational management and performance verification October 2011 – SHTM 03-01 Part B v1 dated October 2011)**[8] and therefore not in our view a derogation. This type of approach has been reinforced by the new SHTM 03-01 Part A Feb 2022 which now also sets out a hierarchy of ventilation strategies in order to reduce energy costs and provide a more sustainable healthcare estate and support the declared zero carbon target, ventilation selection should be : First choice - Natural Ventilation, Second Choice – mixed mode ventilation, Final option – mechanical ventilation. Although the

[8] Bundle 1 – Published Guidance, Item 2, Page 103

Reference Design Team compliance statement was issued in March 2012, we were formally instructed by Mott McDonald on 12 Sept 2012 to provide a further EM update to align with SoA V13. We were not asked for confirmation that the final version of the EM complied with published guidance. I have been asked to consider potential errors highlighted in the Inquiry's Provisional Position Paper on the Environmental Matrix at paragraph 7.12 and on page 28 and state whether I agree that these were all errors in terms of compliance with HTMs. I do not agree for the reasons stated below.

31. From Paragraph 7.12 -

Tables abstract information from the HK RHSC Only Scheme original issue EM: B1 Crit Care/HDU/Neonatal Surgery - Open Plan Bay (4 beds) : Whilst HTM 03-01 Part A Appendix 2 Table lists 10 ac/hr Supply (note SHTM 03-01 was not published until 2011 but also lists 10 ac/hr Supply in Appendix 1 Table A1) , however HBN 57 Facilities for Critical Care P27 Clause 4.52 states that Mechanical ventilation should ensure that both supply and extract systems are in balance and also HTM 03-01 yr 2007 Clause 2.13 also advises Supply & Extract should be provided in ICU's where there is a need to control room pressure in relation to adjacent spaces. Hence the most onerous guidance taking into account guidance context beyond the Table was applied being 10 ac/hr both supply and extract with balanced pressure relating to the department overall. The matrix guidance notes cross refer to HBN 57 as well as HTM 03-01 for context in this regard. This is a good example of why iterative review of any EM is necessary across design stages to arrive at an agreed solution taking into consideration context and overall department and room layouts.

Crit Care/HDU/Neonatal Surgery – Single Bed Cubicle : This table seems to abstract from HK RHSC Only EM original issue 09 Sept 2010. This Single Bed Cubicle Room was revised to 10 ac/hr S&E on the 22 December 2010 EM revision.

C1 InPatient Pathway/Ward Care – 4 Bed Room and Bedroom Single : The table comparison does not reference the initial client deviation from guidance i.e. HTM 03- 01 = 28C maximum versus client brief = 25C maximum. The client brief for T Max 25C for the patient bedrooms meant that a natural

ventilation only approach meeting T max 25C (which is significantly more onerous than the requirement within HTM 03- 01 yr 2007 Clause 2.15 i.e. internal temperature in patient areas do not exceed 28C for more than 50 hrs pa) was not feasible according to the Design Thermal Comfort simulation studies undertaken (Referred to under Note 14 of this EM). Hence all of the above drove the Design Approach for a mixed mode ventilation approach which provided for natural ventilation but avoided a total reliance on natural ventilation also and whilst doing so could also meet the T max 25C criteria with 4 ac/hr cooled supply air supplemented by natural ventilation. Our view is this was a valid approach in relation to HTM 03-01 from 2007 and which has subsequently been restated and reinforced with a listed hierarchy in new SHTM 03-01 from year 2022.

P28 -
Tables abstract information from the RHSC-DCN Reference Design Scheme EM's:

B1 PICU / HDU - PICU Open Plan Bay 4 Beds and High Acuity Single Cot Cubicle : The departmental room cell 4 ac/hr listing was a transcript error, should have referred to HDU 10 ac/hr, creating a discrepancy with EM Guidance Notes and Room Function Reference Sheet

B1 PICU / HDU - High Acuity – 6 beds -Single Bed Isolation Cubicle : HK EM references HBN 4 which is cross referred to in HBN 57 for Critical Care Facilities. SHPN 4 Supplement 1 (2008 version) ***(A33662184 – Scottish Health Planning Note 04, In-patient Accomodation Options for Choice Supplement 1 Isolation Facilities in Acute Settings dated September 2008)***[9] *carries the same Engineering Requirements Guidance as that explained in HBN 4 Supplement 1.*

32. In summary, the original EM was generated as a tool to promote discussion and feedback through a process, a process which on RHSC did not come to a conclusion and on RHSC DCN Reference Design ended at an early stage of design, and so not a complete process for either set of matrices.

[9] Bundle 1 – Published Guidance, Item 5, Page 518

33. The only explanation I have for the discrepancy occurring in the first place during the Reference Design period is that there was possibly less focus on the Sick Kids matrix department sheets when the room function reference sheet was created and when the schedule of accommodation was updated leading to the anomaly between the department sheet cell and the matrix guidance notes and room function reference sheet. In the original Sick Kids matrix, we did, have the correct air change rate for a high dependency room at 10 air changes. I think between that and knowing that the original matrix was correct, we've just been convinced into believing something that has been correct was still correct. That is the only way I can rationalise it because we did miss that. Having spent considerable time on the Design when the Sick Kids was a capital funded project our mindset was fixed that the EM was correct, which would allow us to focus on the DCN add-on and drafting the EM for that whilst also creating the new format with the Room Function Reference Sheet overall. On reflection the EM does state that users should refer to guidance notes and the guidance notes are correct and at the very least I would have thought a question could have been raised on that to have it clarified. The normal routine judgment as an engineer would be always to go with the most onerous condition until it's clarified.

34. I have been asked to confirm if a room data sheet produced using ADB would have contained the same inaccuracy. My view is the potential for discrepancies are also possible using ADB RDS output which is why we have stated ADB RDS sheets would also need to follow a sense checking and user group review process in the same way as any EM.

35. In regards to the original RHSC only project EM and the basis on which 10 air changes per hour was listed for both supply and extract with balanced pressure for the open plan bay 2,3 and 4-bed rooms, whilst year 2007 HTM 03-01 Part A, Appendix 2, lists 10 ac/hr supply (note SHTM 03-01 was not published until 2011 but also lists 10 ac/hr supply in Appendix 1 Table A1), HBN 57 Facilities for Critical Care (Document Purpose listed as Best Practice Guidance) p27 Clause 4.52, states that mechanical ventilation should ensure that both supply and extract systems are in balance. Note also that HTM 03-01 Part A of 2007 Clause 2.13 and SHTM 03-01 Part A of 2011 Clause 2.9 also advises Supply & Extract should be provided in ICU's where there is

a need to control room pressure in relation to adjacent spaces. Hence the most onerous guidance taking into account guidance context beyond the Table was applied being 10 ac/hr both supply and extract with balanced pressure relating to the department overall. The matrix guidance notes cross refer to HBN 57 as well as HTM 03-01 for context in this regard. This is a good example of why iterative review of any EM is necessary across design stages to arrive at an agreed solution taking into consideration context and overall department and room layouts.

36. The Environmental Matrix dated 9th September 2010, was prepared for the original RHSC standalone project and not associated with the Reference Design for the combined RHSC/DCN Project. The page 5 matrices for department B1 Critical Care/HDU/Neonatal Surgery for the Open Plan Bed Bays was consistent with the Page 2 Guidance Notes, listing 10 ac/hr S&E for these critical care ward rooms.

37. I have been asked if there were ever any discussions around the requirements of CEL 19 (2010), which states essentially that ADB room data sheets are the default position unless there was justification by Lothian Health Board for using a different system. It was not raised in meetings, conversations or anything that I was part of. I do think it's interesting, though, that the new SHTN 02-01 from Oct 2021: Sustainable Design and Construction (SDaC) Guide document requires the use of an EM and states with regards Environmental Matrix " It is expected that 'sense checking' with appropriate end user groups (including HFS/FM/Estate Management representatives) will commence at an early stage and continue throughout all project delivery stages.".

Thermal Comfort Analysis/Reports

38. The HK Thermal Comfort Analysis Report, dated 17/02/2012, demonstrated that with natural ventilation only in summertime and with stated simulation component properties, ward rooms could potentially experience significant hours of internal temperatures above 25oC and up to 28oC, and in many cases more than 50 hours above 28oC referred to in SHTM 03-01 guidance. The simulation analysis at the time showed that in summertime the internal temperatures in ward rooms could be maintained at comfortable levels with 4 ac/hr (air changes per hour) of cooled fresh air supply with mechanical ventilation and could be controlled in summertime between 22oC and 25oC maximum. The rooms could also benefit from supplementary natural

ventilation. The report conclusions noted that the envisaged approach was not intended to be prescriptive and alternative approaches where put forward beyond the Reference Design, could also be valid provided the conditions of planning were not compromised and could be complied with and that the level of thermal comfort achieved satisfied the clients brief and expectations.

39. The Reference Design for the RHSC-DCN scheme was to adopt the approach of having natural ventilation, opening windows accompanied with mechanical ventilation i.e. a mixed mode ventilation approach. This would address the client's wishes and ensure that they did not have the same experiences as the original Edinburgh Royal Infirmary PFI scheme, where there was feedback that natural ventilation only wards would overheat during hot weather to the point where patients and staff were uncomfortable. The natural progression for the Sick Kids only project and the subsequent RHSC-DCN Reference Design was the client's criteria to limit the maximum temperature in a ward room to 25 degrees in summer time.

40. The most current guidance at the time was from HTM 03-01 2007, as SHTM 2025 2001 at that time did not reference air change rates at all (other than operating suites and a few general rooms). It referenced encouragement of natural ventilation where possible, but tested against a criteria where the internal temperature would be no greater than 3 degrees above the external shade temperature at any point in time. HTM 03-01 has a criteria that still recognises and encourages the approach of natural ventilation where possible, but asks for an overheating criteria to be tested of 50 hours per annum over 28 degrees internal temperature. The client felt from their experiences of the original ERI that the 50 hours over 28 degrees was not good enough and so a redefined criteria of 25 degrees maximum for ward bedrooms was sought, which led to still having the motivation to utilise natural ventilation, because we have a local climate that can take advantage of that most of the time, but also to try and address the 25 degrees. The mixed mode ventilation approach of 4 air changes of cool supply air with natural ventilation was supplemented to try and match the 6 air change criteria that was in HTM 03-01 at that time. I also advised a mixed mode ventilation approach was a valid approach described in the guidance current at the time of the original RHSC only design and the later RHSC DCN reference design and that the new SHTM 03-01 Part A Feb 2022 now also sets out a hierarchy of ventilation strategies in order to reduce energy costs and provide a more sustainable healthcare estate and support

the declared zero carbon target, ventilation selection should be as follows : First choice - Natural Ventilation, Second Choice – mixed mode ventilation' Final option – mechanical ventilation. It also needs to be highlighted that an exclusively naturally ventilated approach to any ward bedroom would not provide 6 ac/hr with windows closed.

41. When we moved to the RHCYP/DCN reference design the criteria hadn't changed, however SHTM 03-01 arrived then around October 2011, which was the first update since SHTM 2025 - year 2001, which had no air change rate criteria (other than operating suites and a few general rooms). There were lots of parallels between SHTM 03-01 and HTM 03-01 and some subtle differences, but mostly the same. The philosophy and criteria had not changed and we tested through a thermal comfort simulation model to ensure that the criteria could still match what the client was seeking for the RHCYP/DCN design. Incidentally, within the thermal comfort report with regards to critical care, the report stated in clause 2.6 that: "As such critical care and high dependency type ward rooms which receive air change rates in the region of 10 ac/hr, have not been analysed in this study." This statement aligned with our intention under the Reference Design that Critical Care and High Dependency Bed Areas would receive the 10 ac/hr design approach as noted within the Guidance Notes listed within the Reference Design Environmental Matrix.

Building Research Establishment Environmental Assessment Method (BREEAM)

42. I have been asked by the Inquiry if I believe that trying to achieve energy efficiency targets using the BREEAM model played a part on the air change rate discrepancies. The driving influence on the actual air change rate for a healthcare scheme is driven by HTM and SHTM guidance not by BREEAM.

43. There is a connection between air change rates, energy consumption, energy targets and large acute healthcare facilities that have high air change rate departments. During the reference Design process for RHCYP/DCN I expressed advice to other parties where I specifically mentioned critical care departments being high air change rate. The connection between the solutions for the departments in terms of air movement, heating, cooling and fan energy associated with a movement

of fresh air manifests in high energy consumption. So with the heating and cooling burden, the power consumption that drives the AHU fan systems that moves and treats the fresh air, all means that where there is motivation to have the most energy efficient, low energy, low carbon facility, there are always challenges and aims to promote natural ventilation or mixed mode ventilation where possible to reduce energy demand.

44. I recall the debates at the time of drafting the Reference Design for the RHCYP/ DCN, where very low aspirational real operational energy targets were getting thrown into the melting pot and I expressed the view that adopting those targets would be extremely challenging in my experience for an acute facility of that size and type. I expressed what I thought was achievable and I reinforced that advice using reference information from healthcare guidance, EnCO2 HTM 07-02, which has record data of operational energy for a number of hospitals across the UK. I was referencing what I thought was in the design against what I thought the energy that would manifest in real-life operations and expressing that it was more likely to be a level different from client aspirations and targets that were being suggested.

45. In regards the meeting of BREEAM targets there was a bit of a disconnect here as BREEAM has many elements within it that are assessed under an environment assessment criteria. One of those sections of the assessment criteria is to do with energy and under that assessment there is one criteria, that is called ENE01 credit, which defines the number of points you get against a carbon emission score. It's not anchored against real-life total operational energy, it's anchored against a building regulations compliance model. So building regulations assess "regulated" energy and these assessments can be made of different types of buildings and facilities. The energy is assessed against NCM (National Calculation Model) templates that go into the building regulations compliance model, which do not align with the air change rates for UK healthcare. So air change rates that go into the building regulation compliance model templates for a hospital facility in the UK are much less than the real life HTM/SHTM guidance air change rates within a healthcare facility and are not intended to be used as a measure of real life operational energy.

46. What is often termed unregulated energy or non-regulated energy and by that I mean energy that's not in the building regulation energy model but exists in the real

life operational hospitals is not reflected in the building regulations compliance model and it's not meant to be. This is the process energy, which comes from compressed air, medical gas, vacuum plants, renal dialysis, water treatment plants, a whole host of process energy functions and burdens that are in large acute hospitals but not in these models as well as the reality of HTM/SHTM full fresh air high air change rates and the real life energy consumption associated with that.

47. There was a client brief and a BREEAM target sought, however BREEAM is defined against the assessment criteria that's current at any point in time, as the criteria is shifting and moving. Under the Sick Kids only project we were using BREEAM Healthcare 2008 as the criteria which it was registered against. Upon moving to the NPD model of the RHCYP/DCN Reference Design we kept the project registration against the BREEAM 2008 criteria rather than the new BREEAM 2011 criteria . We had a debate with the client about retaining that registration and letting it carry through for the Reference Design and for the actual delivery of the project. This would have given the client a better chance of achieving a BREEAM rating of excellent, which was relatively easier than the later BREEAM criteria, which came out in 2011 **(A34957859 – Hulley and Kirkwood Consulting Engineers Ltd, 'Reference Design Stage BREEAM 2008/2011 Comparison and Project Implications' – September 2011 (Issue No.2, Rev A))**[10].

48. During the Reference Design for the RHCYP/DCN the client NHSL sought a target of excellent against BREEAM . We asked the client if they wanted to try and test it against the new BREEAM criteria or hang on to the old criteria as it would be easier to achieve excellent. The client requested a report outlining the differences between both the new BREEAM criteria and the old BREEAM criteria and the risks for each. This report was produced. However I'm not sure if it was carried forward or the actual building was assessed against the new criteria beyond the Reference Design period.

<u>Responses to Rule 8 request dated 29 July 2021</u>

49. I have been asked by the Inquiry why no air changes per hour was specified for both supply and extract for the single bed isolation cubicle and the significance instead

[10] Bundle 2 – Reference Design and Invitation to Participate in Dialogue (ITPD) Documents, Item 19, Page 687

of the reference under “Type” to HBN4. Within HTM 03-01 Part A 2007 Appendix 2, Ward Isolation Room Table, no air changes are listed, instead there is a reference to “See Health Building Note 04-01 (Supplement 1) “. Also, within HBN 57 Clause 4.56, Ventilation of single bedrooms, reference is made to the HBN 4 Supplement 1 (2005 version) approach. This approach involves providing supply air to a PPVL (positively pressurised ventilation lobby) to then pass the supply air through to the isolation room indirectly and then extracted via the room or en-suite or both depending on layout. It was therefore felt that it would be clearer to refer to HBN4 rather than listing an air change rate for the actual Isolation Room which may have been misleading. This is also the approach taken in HTM03-01 Appendix 2 Table listing for Ward isolation room.

50. I have been asked by the Inquiry why balanced pressure was specified for the single bed isolation cubicle. Within HBN 57, Clause 4.56, the HBN 4 Supplement 1 (2005 version) approach was applied which is a PPVL (positively pressurised ventilation lobby) to provide a balanced supply and extract approach to the actual Isolation room, with the pressurised lobby providing the barrier.

51. I have been asked by the Inquiry why the basis on which 4 air changes per hour was specified for supply and no air changes per hour was specified for extract for the open plan bay 4-bed rooms. The Reference Design Environmental Matrix of 3 Feb 2012, within Page 5, Dept Code B1 for Critical Care/HDU/Neonatal Surgery Department Sheet, is where the “Room Function” association was assigned. This was taken from the spreadsheet of the Accommodation SoA room definitions of “Open Plan Bay (4 beds)” to align with the Room Function Sheet Reference for “Multi-bed Wards” data, which then unintentionally attributed the 4 ac/hr supply condition for these rooms within this department. This created the discrepancy with the Guidance Notes listed 10 ac/hr. There is however a cross reference to “See Guidance Notes” within the Notes Column of the Department sheet. This should have highlighted the anomaly of the listed 4 ac/hr relative to overarching Guidance Note 15 and the stated need for 10 ac/hr, specifically for HDU bed areas/Critical Care areas. With regards why no air changes per hour was specified for extract for General ward open plan bay 4 bed rooms, the concept was that these were the mixed mode natural/mechanical type ward rooms where extract could be provided by virtue of en-suite toilet extract .

52. I have been asked by the Inquiry in relation to the single bed isolation cubicles, why under the columns for supply and extract air changes per hour reference was made to “HBN4 Dependant” with balanced air pressure. Within HBN 57 Clause 4.56, Ventilation of single bedrooms, reference is made to the HBN 4 Supplement 1 (2005 version) approach. Within HTM 03-01 Part A 2007 Appendix 2, Ward Isolation Room Table, no air changes are listed, instead there is a reference to “See Health Building Note 04-01 (Supplement 1) “.(Note that SHTM 03-01 Part A from October 2011 Appendix 1 Table A1 refers to SHPN 4 Supplement 1 (2008 version) which carries the same Engineering Requirements Guidance as that explained in HBN 4 Supplement 1). This approach involves providing supply air to a PPVL (positively pressurised ventilation lobby) to then pass the supply air through to the isolation room indirectly and then extracted via the room or en-suite or both depending on layout. It was therefore felt that it would be clearer to refer to HBN4. Also within HBN 57 Clause 4.56, the HBN 4 Supplement 1 Approach was applied which is a PPVL (positively pressurised ventilation lobby) to provide a balanced supply and extract approach to the actual Isolation room. Note also the Matrix Guidance Note 21 also refers.

53. I have been asked by the Inquiry the basis on which the discrepancy arose between guidance note 15 (which specified 10 air changes per hour for critical care) and section B1 of the Environmental Matrix (which specified 4 air changes per hour for supply to the open plan bay 4-bed rooms in critical care. I have explained this in paragraph 43.

54. I have been asked by the Inquiry In relation to the Ward Room Thermal Comfort Analysis Report dated 21 February 2012, confirmation of why the reference at paragraph 2.6 to air change rates “in the region of 10 ac/hr" for critical care areas was not mirrored in the Environmental Matrix dated 3 February 2012 or its subsequent revision dated 13 March 2012. The Environmental Matrix Guidance Notes Note 15 does make reference to 10 ac/hr for Critical Care Areas. The discrepancy arose in the Page 5 Dept Code B1 for Critical Care/HDU/Neonatal Surgery Department Sheet where the “Room Function” association was assigned within the spreadsheet from the Accommodation SoA room definitions of “Open Plan Bay (4 beds)” to align with the Room Function Reference Sheet “Multi-bed Wards” data which then attributed the 4 ac/hr supply condition, creating the discrepancy with the Guidance Notes listed 10 ac/hr. There is however a cross reference to “See Guidance Notes” within the Notes

Column of the Department sheet which should have highlighted the anomaly of the listed 4 ac/hr within this particular department relative to Guidance Note 15 and the need for 10 ac/hr for HDU bed areas/Critical Care areas

55. I believe that the facts stated in this witness statement are true. I understand that this statement may form part of the evidence before the Inquiry and be published on the Inquiry's website.