SCOTTISH HOSPITALS INQUIRY

Provisional Position Paper 12

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

Contents

GLOSSARY

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

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

1. Purpose of the PPP

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

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

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

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

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

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

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

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

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

Wards considered in this PPP

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

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

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

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

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

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

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

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

1.9 This PPP:

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

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

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

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

Procedure to be adopted

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

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

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

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

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

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

exists to support that conclusion.

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

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

2. Ventilation Tables for Relevant Wards

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

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

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

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

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

3. Contractual context

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

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

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

Clinical Output Specification (COS)

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

Wards[3] It should be noted that no COS was ever prepared for the BMT Unit.

External design and construction standards

3.4 NHS Guidance has been evolving over many decades[4] with certain guidance being superseded completely (for example, the SHTM 03-01 series superseded the SHTM 2025 series in February 2013[5]) while other guidance was updated so there were more recent versions (for example, the SHTM 03-01 issued in 2013 was subsequently revised and reissued in 2014 and then again in February 2022).

3.5 The NHS Guidance includes the following types of guidance:

- Scottish Health Technical Memoranda (SHTM): These give comprehensive advice and guidance on the design, installation and operation of specialised building and engineering technology used in the delivery of healthcare (for example medical gas pipeline systems, and ventilation systems). They are applicable to new and existing sites and are for use at various stages during the inception, design, construction, refurbishment and maintenance of a building[6].

- Scottish Health Facilities Notes (SHFN): These give comprehensive guidance on the operation of healthcare facilities. The topics within the group of guidance includes infection prevention and control, cleaning services frameworks, security, and health and safety[7].

- Scottish Health Planning Notes (SHPN): These give comprehensive guidance on the operation of healthcare facilities. The topics within the guidance include planning for in-patient facilities for both adults and children, accident and

[3] COS for NSGACL Generic Wards NSG_iss1_rev; COS for NSGACL Haemato Oncology NSG_iss1_rev; COS for NSGACL Haemat-Oncology NCH_iss1_rev.
[4] Statement of Edward McLaughlan, paragraph 6, page 3, for Edinburgh Hearing on 9 May 2022. See also Statement of Andrew Poplett, para 9, at p. 5.
[5] Note that the Draft for Consultation SHTM 03-01 Part A Design and Validation was produced in March 2009 and fell within the NHS Guidance applicable at the time of the contract. The final approved and published version of the draft guidance applied from February 2013.
[6] Statement of Edward McLaughlan, paragraph 16, page 6, for Edinburgh Hearing on 9 May 2022.
[7] Statement of Edward McLaughlan, paragraph 16, page 6, for Edinburgh Hearing on 9 May 2022.

emergency facilities, and isolation facilities[8].

- Scottish Health Technical Notes (SHTN): These provide comprehensive guidance on a range of healthcare specific standards, policies and current best practice[9].

- Health Building Notes (HBN)[10]: These provide best practice guidance on the design and planning of new healthcare buildings and on the adaptation or extension of existing facilities[11].

- Health Technical Memoranda (HTM[12]): These provide guidance for anyone involved in the design, installation or operation of healthcare ventilation. Their primary focus is as engineering technical documents but they include contributions from not only engineers, but also infection prevention control specialists and manufacturers[13].

3.6 An NHS body procuring a new hospital must develop a project brief that should ordinarily specify that the design and build is in compliance with the above NHS Guidance[14]. However, derogations from the guidance documents may be agreed at the time of the contract[15]. The requirements of NHS Guidance are the fundamental starting block of any hospital design[16]. They are the best practice guidance for hospital design[17].

3.7 There are legitimate and sound reasons why contractual parties may decide to derogate but the derogation should be assessed, and the implications considered[18]. The derogation from NHS Guidance should be fully documented

[8] Statement of Edward McLaughlan, paragraph 16, page 6, for Edinburgh Hearing on 9 May 2022.
[9] Statement of Edward McLaughlan, paragraph 16, page 6, for Edinburgh Hearing on 9 May 2022.
[10] HBNs are derived from NHS Improvement in England but approved by Health Facilities Scotland for use in Scotland. To be clear, unlike the other guidance notes, there is no separate Scottish document.
[11] Statement of Edward McLaughlan, paragraphs 16 and 17, pages 6 and 7, for Edinburgh Hearing on 9 May 2022.
[12] This is a document applicable only in England and Wales but the Scottish SHTM is based on this. The HTM was included in the NHS Guidance and applied to the QEUH and RCH on a contractual basis.
[13] Statement of Andrew Poplett, paragraph 8 at p.4. and paragraph 65 at p. 29.
[14] Bundle 6, Expert Report of Stephen Maddocks, at p.16 (Bundle p.68)
[15] Bundle 6, Expert Report of Stephen Maddocks, at p.16 (Bundle p.68)
[16] Bundle 6, Expert Report of Stephen Maddocks, at p.16 (Bundle p.68)
[17] Bundle 6, Expert Report of Stephen Maddocks, at p.18 (Bundle p.70)
[18] Oral evidence of Andrew Poplett, Hearing on 10 May 2022, at p.121 and p.122.

and recorded in the project file and the record maintained for the life of the building[19]. A derogation from NHS Guidance that could impact on patient or staff safety should never be undertaken[20].

Statutory Compliance

3.8 The ventilation system in the relevant wards also required to comply with statutes and regulations[21].

3.9 The *Health and Safety at Work etc Act 1974* is one of the statutes that falls within the list in the Employer's Requirements and is relevant given that the ventilation system is intended to prevent contamination, closely control the environment, dilute contaminants and contain hazards[22].

3.10 The ventilation system must also comply with the *Building (Scotland) Regulations 2004*. Building Standard 3.14 covers ventilation and states that:

> "Every building must be designed and constructed in a way that ventilation is provided so that the air quality inside the building is not a threat to the building or the health of the occupants[23].

3.11 In accordance with the Scottish Building Standards, the minimum mechanical ventilation requirement for an occupied space is to provide an average eight litres of fresh air per person per second[24]. There is no further specification in the Scottish Building Standards as to the air quality for a building such as a hospital.

The Design Process

3.12 For context, it is necessary to refer to some design documents and processes. A short summary of key documents and processes is provided in this section for

[19] Oral evidence of Andrew Poplett, Hearing on 10 May 2022, at p.122.
[20] Oral evidence of Andrew Poplett, Hearing on 10 May 2022, at p.123.
[21] Employer's Requirements, Section 5.0 (General Design and Construction Requirements) [Additional Guidance] paragraph 5.1.4
[22] CSCIE at para 43.
[23] CSCIE, para 44.
[24] Section 3.14.5 Mechanical Ventilation, Environment (Non-domestic buildings, Technical Handbook 2017).

context purposes only.

The Activity Database ("ADB") system is standardised hospital design tool used by the NHS in the UK. It is a digital database of hospital design information including detailed requirements for clinical spaces in hospital It can be used to create a Room Data Sheet ("RDS"). Every room in a hospital project will have its own individual RDS that captures the fundamental elements (number of sockets, ventilation air change rate, provision of fire alarm etc)[25].

The ventilation parameters appear on a RDS for the room environmental data along with others such as lighting and noise parameters. When RDS are generated from the ADB, the ventilation parameters will in most cases be derived from HTM 03-01 Part A (2007).

To facilitate communication about environmental parameters, engineers devised an Environmental Matrix[26]. This is a spreadsheet which gathers together in one place, for all rooms in a building, certain parameters bearing upon its mechanical and electrical engineering systems.

The Contract contained a process for the review of certain design deliverables such as clinical functionality, specifications including finishes, colour schemes, materials and components referred to as Reviewable Design Data ("RDD").

Changes and Derogations

3.13 The M&E Clarification Log (2010 ItP) – Final is an important record of changes, derogations and clarification and as approved takes precedence over both the Employer's Requirements and the Contractor's Proposals in respect of the items contained in the log[27].

3.14 The Contract had several logs to record derogations from the original scope during the build phase, but the 'M&E Clarification Log (2010 ItP) – Final' document which is referred to in this PPP ultimately recorded the agreed derogations at

[25] CSCIE, at para 68
[26] CSCIE, at para 72.
[27] Contract Data part one of the Contract, Appendix 5.

handover[28] and is used for the purposes of this PPP to assist in identifying whether key features are present or absent at handover. An excerpt from the M&E Clarification Log (2010 ItP) – Final concerning the agreed derogation of ACH is set out in Appendix 4 of the PPP.

Commissioning & Validation

3.15 The HTM-03 Part A (2007) states at page 80 that commissioning is:

> "an essential process for ventilation systems. It is therefore important that adequate provision for the process be made at the design stage of the project. Procedures for commissioning air-handling systems are given in CIBSE Commissioning Codes and BSRIA Application Guide Set COMPAK 1."

3.16 Commissioning is setting to work the ventilation system to make sure it is balanced, and the individual components function as they are designed[29].

3.17 Furthermore, the HTM-03 Part A (2007) states at page 66 that validation is:

> "A process of proving that the system is fit for purpose and achieves the operating performance originally specified. It will normally be a condition of the contract that 'The system will be acceptable to the client if at the time of validation it is considered fit for purpose and will only require routine maintenance in order to remain so for its projected life."

3.18 HTM-03 Part A (2007) goes on to state at page 66 that:

> "It is unlikely that "in-house" staff will possess the knowledge or equipment necessary to validate critical ventilation systems such as those serving operating suites, pharmacy clean rooms and local exhaust ventilation systems. Validation of these systems should therefore be carried out by a suitably qualified Authorised Person appointed by the client."

3.19 Validation is a process where, usually an independent company, checks that all

[28] Contract Data part one of the contract, Appendix 5.
[29] Oral Evidence of Andrew Poplett, Hearing on 10 May 2022, at p.112.

the components work together (for example, the fire alarm system and the ventilation system) once the construction has been completed. Validation is usually offered before practical completion and completed after practical completion [30].

3.20 Any non-compliance with the Draft for Consultation SHTM 03-01 Part A (2009) noted by the independent third party would be flagged up to the NHS body[31]. However, in a PMI in July 2013, GGC agreed that the independent commissioning engineer under the Contract could be staff from Multiplex[32]. The Inquiry team have been unable to locate any specific contractual provisions in the Employer's Requirements for the validation of ventilation equipment in the QEUH/RHC contract documents. It is not known if this reflected standard or accepted practice at the time. However, there is a validation process set out within Draft for Consultation SHTM 03-01 Part A (2009)[33].

3.21 Following the commissioning and/or validation, a full report detailing the findings should be produced, and the ventilation system will only be acceptable to a client such as GGC if:

> "…at the time of validation it is considered fit for purpose and will only require routine maintenance in order to remain so for its projected life[34]."

3.22 The report should conclude with a clear statement as to whether the ventilation system achieved or did not achieve the required standard. A copy of the report should be lodged with the following groups:

- the user department
- infection control (where required)

[30] Andrew Poplett, Hearing on 10 May 2022, at p.113 and p.114.
[31] Stephen Maddocks, Hearing on 12 May 2022, at p. 38.
[32] PMI 231, 8 July 2013.
[33] Draft for Consultation SHTM 03-01 Part A at paragraphs 8.67 to 8.174.
[34] HTM-03 Part A (2007), at page 73, para 8.64.

- estates and facilities[35]

Annual Verification

3.23 Critical ventilation systems require annual verification and quarterly maintenance checks. General ventilation systems do not require annual verification, but they do require annual maintenance[36].

3.24 Annual verification for critical ventilation systems is intended to establish that the ventilation system is still required, and that the AHU conforms to the minimum standard[37]. Amongst other things the annual verification is intended to establish that the general condition of the ventilation system is adequate in relation to ACH, pressure differentials and air-flow rates[38].

3.25 Ventilation system records and logbooks should be kept of commissioning information, operational management routine, monitoring and maintenance. The Health and Safety Executive ("HSE") and other interested bodies have a statutory right to inspect them at any time. All records should be kept for at least five years[39].

2015 Handover

3.26 On 29 January 2015, stage 3 (QEUH and RHC) sectional completion was certified to be 26 January 2015, 4 weeks earlier than the scheduled Completion Date of 28 February 2015[40].

3.27 Although the Employer's Requirements stated that the QEUH and RHC would have natural and mechanical ventilation[41], the Inquiry team understands that

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[35] HTM-03 Part A (2007), at page 73, para 8.65.
[36] Draft for Consultation SHTM 03-01 Part B – Operational management and performance verification
[37] Draft for Consultation SHTM 03-01 Part B – Operational management and performance verification at paras 3.3 to 3.63, p.18 to p.24.
[38] Draft for Consultation SHTM 03-01 Part B – Operational management and performance verification at para 4.9, p.26.
[39] Draft for Consultation SHTM 03-01 Part B – Operational management and performance verification at paragraph 1.26, p.13.
[40] NHSGGC Sectional Completion Certificate dated 26 January 2015.
[41] Employer's Requirements, Section 5.0 (General Design and Construction Requirements) [Control of Infection] paragraph 5.6.1(b), Section 7.0 (Architectural Requirements) [Building Envelope]at paragraphs

parties must have agreed at some stage to have a fully mechanical ventilation system. The NSHG Ventilation Strategy (December 2009)[42] document notes that natural ventilation would not achieve GGC's temperature control requirement and sole use of mechanical ventilation was explored. The requirement for partly natural ventilation appears to have been impliedly derogated from in the M&E Clarification Log (2010 ItP) – Final as it stated that Chilled Beam Units ("CBUs") were the solution to control the environment which was not reliant on variable natural ventilation[43]. At handover in 2015, the QEUH and RHC were largely sealed with limited openable windows in order to control the internal environment within the spaces and limit the impact of odours from the adjacent Scottish Water works[44].

4. Purpose of Ventilation

4.1 In order to enable this PPP to be understood by a lay reader this section seeks to summarise the purpose of ventilation systems in a hospital by reference to evidence led in the Edinburgh hearing of the Inquiry that commenced on 9 May 2022 and the submissions of Counsel to the Inquiry in respect of that evidence.

4.2 Ventilation is the provision of air to dilute contamination generated within a space in order to provide a safe, suitable and comfortable environment to undertake an activity within a space[45].

4.3 Ventilation has three functions in a hospital:

- removal of odour and noxious smells;
- maintenance of comfortable temperature for patients and staff; and
- assisting in the prevention and control of infection[46].

4.4 Ventilation can be provided naturally by the effects of wind pressure (for example,

7.7.2(a) and (b), Section 8.0 (Building Services Requirements) [Ventilation and Air Conditioning] at paragraph 8.2.11.7.
[42] NHSG Ventilation Strategy (December 2009).
[43] M & E Clarification Log (2010 ItP) – Final.
[44] QEUH and RCH Building User Guide (FM) dated 23 January 2015 at p.24.
[45] Oral Evidence of Andrew Poplett, Hearing on 10 May 2022, at p.16.
[46] Bundle 6, Hearing 9 May 2022, Expert Report of Professor Hillary Humphreys, at p.10 (p.12 of Bundle).

opening a window). This would impact on maintaining consistent flow rates resulting in the inability to ensure minimum ventilation rates will be achieved. However, this variability is acceptable within some environments such as an office accommodation or a general hospital ward. Specialist areas will require mechanical ventilation to ensure that the ventilation system performs consistently irrespective of weather conditions[47].

4.5 A correctly designed, installed, and operated ventilation system can really help reduce the risk of infection. An incorrect ventilation system can increase the risk of infection and transmission[48].

4.6 Ventilation is just one control measure among many to reduce the risk of infection in a hospital. Other measures included prophylaxis antibiotics (these are antibiotics used to prevent as opposed to treat infections) and appropriate hand hygiene[49].

4.7 Mere dilution of contaminants will not be appropriate for immunocompromised patients who will require more stringent measures relating to filtration and directional airflow to reduce their risk of becoming acquiring an infection. The use of ventilation is significant for immunocompromised patients or those patients with virtually no immune system because of illness, transplant, or treatment. It can reduce exposure to potential airborne pathogens from surrounding areas or outside[50].

4.8 In a healthcare setting the two main categories of airborne risk are human derived airborne micro-organisms such respiratory viruses and tuberculosis and secondly environmentally derived agents such as fungi and environmental bacteria. Each have their own unique properties but can be considered harmful to patients, particularly vulnerable patients who are neutropenic (reduced number of neutrophil white blood cells). The ventilation must protect the patient from the immediate hospital environment but also from outside air (dust from nearby

[47] CSCIE, at paragraph 36.
[48] Bundle 6, Hearing on 9 May 2022, Expert report of Dr Shaun Fitzgerald, at p.7 (p.36 of Bundle).
[49] Bundle 6, Hearing on 9 May 2022, Expert report of Dr Hilary Humphreys at p. 12 (p.14 of Bundle).
[50] Statement of Andrew Poplett, paragraph 12, at p. 7.

construction work, winds carrying spores such as aspergillus fungus etc)[51].

5. Parameters in a Ventilation System

5.1 In the construction of a hospital building, a critical element is specification of the parameters to be achieved by the building's ventilation system. To design a ventilation system, an engineer will need to know what parameters the system is to achieve[52].

5.2 In the absence of a completed room data sheet, an engineer will have to interpret the relevant technical guidance and may have to make assumptions to determine the parameters to be achieved[53].

NHS Guidance

5.3 The Contract makes specific reference to a range of NHS Guidance which reflected distilled knowledge, consensus and best practice[54] built up over time by those involved in healthcare engineering.

5.4 The Employer's Requirements state that Multiplex shall:

- comply with the documents listed as "NHS Mandatory Documentation";
- have regard to the documents listed as "NHS Guidance Documentation", and
- comply with the standards, legislation and other documents listed in section 5.1.4 (Additional Guidance)[55] such as "current British Standards, European Standards and Codes of Practice, as appropriate".

5.5 The NHS Guidance relevant to this PPP is listed in Appendix 1.

5.6 For context, the earlier SHTM 2025 guidance originally provided guidance in

[51] Statement of Andrew Poplett, paragraph 12, at p. 7.
[52] CSCIE, at paragraph 71.
[53] CSCIE, at paragraph 71.
[54] CSCIE, at paragraph 194
[55] Employer's Requirements, Section 5.0 (General Design and Construction Requirements), at paragraphs 5.1.1.2.

relation to hospital ventilation systems. It stated that specific requirements for individual spaces and departments were included in the ADB A-Sheets[56].

5.7 In the period between the SHTM 2025 issued in June 2001 and the SHTM 03-01 Part A in 2013, there was a draft SHTM 03-01 Part A prepared in March 2009 for consultation (ultimately becoming the 2013 SHTM 03-01 Part A version). The 2013 SHTM 03-01 Part A is described in SHTM 00[57] at page 14 as:

> "…best practice guidance on design and air installation of ventilation systems and the close-control (mechanical cooling or air-conditioning) of general and 'specialised' healthcare environments."

5.8 Part A of the Draft for Consultation SHTM 03-01 concerns the design parameters for new installations. While Part B deals with operational management of systems. Paragraph 2.60 of Part A of the Draft for Consultation SHTM 03-01 states that:

> "Specific requirements for individual spaces and departments are included in the Health Building Notes (HBNs) and Activity Database (ADB) A-Sheets, or Scottish Health Planning Notes (SHPNs)."

Key Ventilation Concepts

5.9 This part of this section of the PPP seeks to explain key ventilation concepts to enable the details set out in both in the narrative text in sections 6 of this PPP and Appendix 2 to be understood by a reader.

HEPA Filtration

5.10 A filter consists of a labyrinth of fibrous material contained in a frame. Its purpose is to capture and hold particles being carried in the airstream. The size, range and number of particles that exist in the air make it impossible for a filter to remove them all.

5.11 A HEPA filter is a High-Efficiency Particulate Air filter. HEPA filters will capture

[56] SHTM 2025 (Pt 2): Ventilation in healthcare premises (June 2001)
[57] SHTM 00 Best practice guidance for healthcare engineering, policies and principles (Feb 2013)

particles. HEPA filters do not filter out gases or odours[58]. There are different grades of filters with the lowest being G2 to G4. In the middle there is EPM 1 (formerly F7). At the top end[59] there is the HEPA filter (H12)[60].

5.12 Immunocompromised or neutropenic areas of a hospital require HEPA filtration[61].

Room Air Change Rate ("ACH")

5.13 In relation to a specific hospital room, the supply of air to a room has four functions:

1. to dilute airborne contamination;
2. to control air movement within such that the transfer of airborne contaminants from less clean to cleaner areas is minimised;
3. to control the temperature and if necessary, the humidity of the space[62]; and
4. to assist in the removal of and dilute waste gases where used[63].

5.14 The general principle for shared rooms is that infection risk increases as the air change rate per hour reduces. 2 ACH is a vital threshold for human health which relates to the build-up of CO2[64]. The position in relation to single rooms is unknown[65] but would ultimately depend on airflows between single rooms, corridors and the number of visitors.

5.15 The number of ACH is not an exact science. Ultimately, it is a compromise agreed between contributors (including engineers and IPC professionals). The number of ACH agreed in the NHS Guidance is based on research conducted by Owen Lidwell and his research group in the 1970s. It is simply an agreed consensus that the stated level of ACH within the NHS Guidance provide a safe environment for

[58] Oral evidence of Andrew Poplett, Hearing on 10 May 2022, at p.57.
[59] It should be noted the highest HEPA filter is H14.
[60] Oral evidence of Andrew Poplett, Hearing on 10 May 2022, at p.56 and p.57.
[61] Oral evidence of Andrew Poplett, Hearing on 10 May 2022, at p. 60
[62] Bundle 6, Expert Report of Stephen Maddocks, at p.20 (Bundle p.72)
[63] Bundle 6, Expert Report of Stephen Maddocks, at p.21 (Bundle p.73)
[64] Queen Elizabeth University Hospital Review Report, June 2020, at paragraph 4.5.25
[65] Queen Elizabeth University Hospital Review Report, June 2020, at paragraph 4.5.25

patients; it does not necessarily follow that failure to comply with the stated level of ACH will always be a risk to patients. That said, non-compliance may create a risk to patients[66].

5.16 ACH is the volume of air present within a room and the number of times that the whole room volume changes. Approximately every air change within a room will remove 63% of airborne contamination so by six air changes 99.8% of any residual airborne contamination will have been removed[67]. Air change rates are calculated by finding out the volume flow rate of air into the room through a given duct against the size of the room that the air is flowing into[68].

Room Air Pressure

5.17 Positive pressure ventilation is used for protecting very vulnerable patients and is known as protective isolation. This is required to protect neutropenic patients such as those undergoing chemotherapy or organ transplantation from exposure to airborne environmental pathogens. The air in these patients' rooms should be higher pressure (for example 5 or 10 Pa) so that it moves to surrounding clinical areas. This prevents the ingress of air with potential airborne pathogens from the rest of the ward[69].

5.18 In some circumstances negative ventilation pressure may be used to prevent infection. This type of pressure ventilation is used where the patient has a transmissible airborne infection (source isolation) and there is a risk of aerosol transmission from the patient spreading to other patients in the ward. In other words, that air does not spread from the isolation room to the surrounding ward as the air pressure is negative there compared to other clinical areas nearby. A patient with a serious lung infection such as tuberculosis would fall into this category of a patient requiring negative pressure[70].

[66] CSCIE, at paragraph 58.
[67] Oral evidence of Andrew Poplett, Hearing on 10 May 2022, at p.28 and p.29.
[68] Oral evidence of Andrew Poplett, Hearing on 10 May 2022, at p .30.
[69] Bundle 6, Hearing 9 May 2022, Expert Report of Professor Hillary Humphreys, at p.11 (p.13 of Bundle).
[70] Bundle 6, Hearing 9 May 2022, Expert Report of Professor Hillary Humphreys, at p.11 (p.13 of Bundle).

Chilled Beam Units ("CBUs")

5.19 A CBU is a radiator-type arrangement that is normally mounted on the ceiling, where warm air rises within a space through convection. The warm air meets the chilled beam which cools down the air and that air moves towards the floor of the room by convection. The air moves in a cycle by convection passively[71].

5.20 An active CBU is exactly the same as a passive CBU but can include a degree of fresh air supply provided by a duct to the CBU[72].

5.21 CBUs are efficient and useful in certain environments such as office buildings with sealed windows and no fresh air[73].

5.22 The use of CBUs in clinical areas of hospitals (bedroom spaces, ward area, patient overnight spaces and treatment spaces) is not recommended by the current edition of HTM 03-01 (although it should be noted that earlier HTM editions, namely the 2007 edition, applicable at the time of the contract did not have this recommendation) because (i) moisture will condense on surfaces and promote the proliferation of micro-organisms; and (ii) they need regular maintenance to keep them operating in a satisfactory condition[74].

Sealed Bedroom/Ensuites

5.23 A sealed ceiling is a ceiling system that is designed to be airtight which should be smooth, jointless and impervious. A suspended ceiling is a group of individual tiles set in a grid.

Airlock Entrance to Ward

5.24 An airlock door barrier is a system designed to control the flow of air between two adjoining spaces, particularly in environments where maintaining specific air quality or pressure is critical. The primary purpose of an airlock is to prevent the uncontrolled exchange of air and contaminants between two areas. The key

[71] Oral evidence of Andrew Poplett, Hearing on 10 May 2022, at p.53
[72] Oral evidence of Andrew Poplett, Hearing on 10 May 2022, at p.53.
[73] Oral evidence of Andrew Poplett, Hearing on 10 May 2022, at p.63.
[74] Oral evidence of Andrew Poplett, Hearing on 10 May 2022, at p54 and p.55.

features of an airlock are two doors in close proximity with one leading into the airlock and the other leading out. The doors do not open simultaneously to minimise a direct path for air to flow between two spaces.

Backup Air Handling Unit ("AHU")

5.25 An Air Handling Unit ("AHU") is a piece of machinery which circulates and regulates air as part of a ventilation system. The primary purpose of a backup air handling unit is to take over the functions of the primary air handling unit in case of failure or scheduled maintenance. Air handling units are used to treat and distribute air throughout the various areas of a hospital. They play a crucial role in maintaining air quality, controlling infection risk, and creating a comfortable and safe environment for patients, hospital staff and visitors.

Pressure Monitoring System

5.26 A pressure monitoring system is a set of tools and devices that are required to monitor specific pressures within a healthcare setting. The purpose of the pressure monitoring system is to inform the relevant people immediately if the ventilation system is operating out of specification, for example, by being alarmed to a nursing station.

6. Ventilation Systems in Wards

6.1 The prevention and control of infection was to be a primary consideration of Multiplex in the design and construction of the QEUH/RHC. Multiplex was required to demonstrate to GGC's ICT that the design and construction of the hospital fully reflected and incorporated the ventilation system, being a key infection control challenge[75].

6.2 This section of the PPP summarises the information contained in the tables in Appendix 2 to the PPP. The tables in that appendix are the principal record of the information contained in this PPP and the following sections are summaries of

[75] Employer's Requirements, at clause 5.6.1 [Control of Infection]

what is contained in the appendix.

QEUH General Wards

6.3 This section summarises the principal features of the ventilation system in the General Wards of the QEUH. The majority of wards in the hospital are general wards. However, it is noted that while Infectious Diseases on Level 5 and Respiratory and Cystic Fibrosis on Level 7 were designed as general wards, they may be considered as specialist wards . All these wards have general ventilation systems installed.

HEPA Filtration

6.4 The NHS Guidance included Draft for Consultation SHTM 03-01 Part A (2009). A G4 filter was deemed suitable for general areas[76].

6.5 The HTM 03-01 Part A (2007) guidance was also specifically listed in the NHS Guidance. In Appendix 2 of HTM 03-01 Part A (2007), a general ward's filter requirement is non-HEPA, SUP2.

6.6 At handover in January 2015, no HEPA filtration was required, and no HEPA filtration was installed at handover. This is therefore **not** a potentially deficient feature for the purposes of Glasgow III.

Room Air Change Rate ("ACH")

6.7 In both Appendix 2 of HTM 03-01 Part A (2007) and Appendix 1 of Draft for Consultation SHTM 03-01 Part A (2009), the number of air changes for general wards is stated to be 6 ACH. Accordingly, NHS Guidance required 6 ACH in the General Wards of the QEUH.

6.8 The M&E Clarification Log (2010 ItP) – Final notes that "Ward Air change to be 6AC/HR, currently shown as 2.5 AC/HR which is not in compliance with SHTM 03-01". Mulitplex's response is recorded as "'… All accommodation is single

[76] Table A1, Draft for Consultation SHTM 03-01 Part A at page 140.

bedrooms and therefore the need for dilution of airborne microbiological contamination should be reduced…Providing 6 air changes is energy intensive and not necessary." The agreed position is noted as "The proposal is accepted on the basis of 40 litres per second per single room (8 litres per second per second) for one patient and four others…." GGC confirmed agreement to this proposed derogation.[77] This was built.

6.9 At handover in 2015 single bedrooms, in general wards had approximately 2.5 ACH which was below NHS Guidance, and this remains the case[78]. This is a potentially deficient feature for the purposes of Glasgow III.

Room Air Pressure

6.10 In both Appendix 2 of HTM 03-01 Part A (2007) and Appendix 1 of the Draft for Consultation SHTM 03-01 Part A (2009), the room air pressure is stated to be "0 or -ve" for a single room. Accordingly, NHS Guidance required that for General Wards room air pressure of 0 or -ve was required in the single rooms within the General Wards of the QEUH.

6.11 At handover in 2015 the room pressure was "0 or slightly -ve relative to the corridor" and this is **not** a potentially deficient feature for the purposes of Glasgow III.

Chilled Beams ("CBUs")

6.12 The Employer's Requirements stated that "the use of active chilled beams should be considered within all ward areas"[79]. The NHS Guidance[80] required that if using CBUs, they be positioned carefully to avoid cold draughts. Control settings ensure that beams' external elements are always above dewpoint and should be easily accessible for maintenance.

6.13 CBUs were installed in the wards at handover. Some core participants and others

[77] M & E Clarification Log Final (2010 ItP) – Final.
[78] M & E Clarification Log Final (2010 ItP) – Final.

[79] Employer's Requirements, Section 2.4 (Main Hospital Building), at paragraphs 2.4.3 [Chilled Beams].
[80] Draft for Consultation SHTM 03-01 Part A at p.30 and HTM 03-01 Part A (2007) at p.11

have challenged the use of CBUs in the QEUH. Furthermore, the use of CBUs in clinical areas, is not recommended by the current edition of SHTM 03-01 (2022). This is a potentially deficient feature for the purposes of Glasgow III.

Commissioning & Validation

6.14 At handover in 2015, commissioning of the ventilation system in the General Wards had been carried out but there was no validation of the ventilation system. This is a potentially deficient feature for the purposes of Glasgow III.

Annual Verification

6.15 The Inquiry team understands that no annual verification of the ventilation system was carried out post-handover until circa 2018 or 2019.

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

6.16 Ward 2A Haemato-oncology (Schiehallion Unit) was located in the RHC.

6.17 Haemato-oncology wards are for patients with a range of malignant and non-malignant haematology conditions. A significant number of the patients receive chemotherapy, which renders them immunocompromised or neutropenic and that leaves them potentially vulnerable to infection.

6.18 The ward provides services in the following areas:

- General in-patient ward (high dependency);
- National Bone Marrow Transplant (BMT) Unit; and
- Teenage Cancer Trust (TCT) ward.

6.19 This PPP considers the in-patient ward and TCT ward. The BMT isolation rooms will be covered in a separate PPP.

6.20 The patients accommodated in the Schiehallion ward (in-patient and TCT ward) were immunocompromised and considered high-risk. This ward required specialist

ventilation; however, it was designed and built as a general ward.

6.21 On 26 September 2018, the patients in Ward 2A were transferred to Ward 6A in the QEUH while upgrade works were carried out in 2019. On 9 March 2022, the patients returned to Ward 2A.

HEPA Filtration

6.22 In Appendix 2 of HTM 03-01 Part A (2007), there are two tables (tables 2 and 3) which summarise the design conditions for specific wards and rooms. A specific ward listed is a neutropenic patient ward and the supply filter grade in table 2 required is "H12" while in table 3 a haematology/oncology ward is "BS EN 1822 - EPA12". These filter grade levels are classified as HEPA filters. The same outcome arises from the Draft for Consultation SHTM 03-01 Part A (2009).

6.23 The RHC COS makes no express requirement for HEPA filtration[81].

6.24 The Inquiry team considers that as a neutropenic patient ward, Ward 2A required H12 HEPA filtration according to NHS Guidance.

6.25 At handover in 2015, HEPA filtration should have been installed, particularly as the ward was accommodating neutropenic patients, but no HEPA filtration was in fact installed within Ward 2A. This is a potentially deficient feature for the purposes of Glasgow III.

Room Air Change Rate ("ACH")

6.26 In Appendix 2 of HTM 03-01 Part A (2007), the number of air changes for a neutropenic patient ward is stated to be 10 ACH. The same outcome arises from the Draft for Consultation SHTM 03-01 Part A (2009). 10 ACH was required in ward 2A.

6.27 The M&E Clarification Log (2010 ItP) – Final includes Multiplex's proposal of 40 litres of air per second per single room, on the assumption a patient and four others occupy a room (this is equivalent to 8 litres per person per second)

[81] COS for NSGACL Haemat-Oncology NCH_iss1_rev

(approx. 2.5 ACH for single bedrooms) which is less than NHS Guidance required[82]. GGC confirmed agreement to this derogation[83].

6.28 The Draft for Consultation SHTM 03-01 Part A (2009) standard of 10 ACH for critical/neutropenic areas, was derogated to 2.5 ACH. This is a potentially deficient feature for the purposes of Glasgow III.

Room Air Pressure

6.29 In Appendix 2 of HTM 03-01 Part A (2007) and Table A1 of the Draft for Consultation SHTM 03-01 Part A (2009) the room air pressure is stated to be "+10 Pa" for neutropenic patient ward.

6.30 The RHC COS refers to the ward benefiting from 'low positive pressure'[84].

6.31 NHS Guidance requires ward room air pressure of +10 Pa for Ward 2A as a ward with neutropenic patients.

6.32 The M&E Clarification Log (2010 ItP) – Final also derogated from room pressure differentials as noted on pages 3 and 4 of the Log where it is stated that "(rooms could also be at slightly negative pressure to corridor)". GGC agreed and noted negative pressure was to be created in the design solution[85]. This is a potentially deficient feature for the purposes of Glasgow III.

6.33 At handover, the room air pressure for this ward was found to be "0 or slightly negative -ve relative to the corridor", broadly in line with the derogation but significantly less than guidance. This is a potentially deficient feature for the purposes of Glasgow III.

Chilled Beams ("CBUs")

6.34 The Employer's Requirements stated that "the use of active chilled beams should

[82] Queen Elizabeth University Hospital Review Report, June 2020, at para 4.5.24
[83] M & E Clarification Log (2010 ItP) – Final
[84] COS for NSGACL Haemat-Oncology NCH_iss1_rev Section 7(1).
[85] M & E Clarification Log (2010 ItP) – Final at pages 3 and 4.

be considered within all ward areas[86]".

6.35 At handover, CBUs were installed in this ward. As some CPs and others have challenged the use of CBUs in the RHC and the use of CBUs in clinical areas is not recommended by the current edition of SHTM 03-01 (2022) this is a potentially deficient feature for the purposes of Glasgow III.

Sealed Bedroom/Ensuites

6.36 The RHC COS[87] did not require sealed bedrooms and ensuites. At handover in 2015, the ward's bedrooms and ensuites were not sealed and had suspended ceilings. However, given the air pressure requirements noted above this is a potentially deficient feature for the purposes of Glasgow III.

Air Lock Entrance to Ward

6.37 The RHC COS required that "The ward should be accessed by entry through a double-door barrier system.[88]"

6.38 At handover, it is understood that there was no airlock in place. One was subsequently fitted in the 2019 upgrade works. This is a potentially deficient feature for the purposes of Glasgow III.

Back Up AHU

6.39 The Employer's Requirements did not require a backup AHU for the ward and one was not installed at handover in 2015. Given the subsequent fitting of a back up AHU in the 2019 upgrade works the absence of one at handover is a potentially deficient feature for the purposes of Glasgow III.

Pressure Monitoring System

6.40 The RHC COS did not require a pressure monitoring system for the ward and one was not installed at handover in 2015. Given the subsequent fitting of a pressure

[86] Employer's Requirements, Section 2.4 (Main Hospital Building), at paragraphs 2.4.3 [Chilled Beams].
[87] COS for NSGACL Haemat-Oncology NCH_iss1_rev, Section 7(1).
[88] COS for NSGACL Haemat-Oncology NCH_iss1_rev, Section 7(1).

monitoring system in the 2019 upgrade works the absence of one at handover is a potentially deficient feature for the purposes of Glasgow III.

Commissioning and Validation

6.41 At handover in 2015, commissioning of the ventilation system in Ward 2A had been carried out but there was no validation of the ventilation system. This is a potentially deficient feature for the purposes of Glasgow III.

6.42 However, following the upgrade works in 2019, those works on the ventilation system were both commissioned and validated.

Annual Verification

6.43 No annual verification of the ventilation system was undertaken post-handover. This is a potentially deficient feature for the purposes of Glasgow III.

Ward 2A Upgrade Works

6.44 In 2019 upgrade works were carried out on Ward 2A which resulted in HEPA filtration being installed. The works increased the ACH from 2.5 ACH to 10 ACH bringing it in line with the Draft for Consultation SHTM 03-01 Part A (2009). The room pressure which was at the same level as a general ward was increased to +10 Pa.

6.45 The 2019 upgrade works also put right other issues by removing the CBUs and sealing the ceilings of the bedrooms and ensuites that had suspended ceilings. The works also installed an airlock at the entrance to the ward, and as illustrated in Table 2, installed a backup AHU and a pressure monitoring system.

6.46 The 2019 upgrade works brought Ward 2A in line with SHMT 03-01 Part A (2022) and no further works are necessary at the present time.

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

6.47 Ward 2B is the Schiehallion Day Care Unit. It is understood by the Inquiry team

that because no patients stay overnight and only receive treatment on an outpatient basis during the day then it is does not fall within the category of a neutropenic ward. Accordingly, the Inquiry Team understands that the default position would be the standard of a general ward. Ultimately, the requirements would need to be defined by clinical IPC who could assess the patient groups and their risk requirements.

HEPA Filtration

6.48 In Appendix 2 of HTM 03-01 Part A (2007), there are two tables (tables 2 and 3) which summarise the design conditions for specific wards and rooms. A neutropenic patient ward would require H12 (HEPA) filtration but since this ward is not considered to be a neutropenic patient ward, then the supply filter grade in table 2 requiring "H12" (HEPA) is not applicable.

6.49 The RHC Haematology and Oncology COS makes no express requirement for HEPA filtration[89].

6.50 At handover in 2015, it is noted that no HEPA filtration was in fact installed within Ward 2B. However, HEPA filtration was later fitted to this ward in the 2019 upgrade works (see below). The absence of HEPA filtration in this ward at handover is **not** a potentially deficient feature for the purposes of Glasgow III.

Room Air Change Rate ("ACH")

6.51 In Appendix 2 of HTM 03-01 (2007), the number of air changes for a general ward is stated to be 6 ACH.

6.52 The Inquiry team considers that for general wards the NHS Guidance required 6 ACH in Ward 2B.

6.53 The M&E Clarification Log (2010 ItP) – Final includes Multiplex's proposal of 40 litres of air per second per single room, on the assumption a patient and four others occupy a room (this is equivalent to 8 litres per second per person) which is

[89] COS for NSGACL Haemat-Oncology NCH_iss1_rev

less than NHS Guidance required[90]. GGC confirmed agreement to this derogation[91].

6.54 At handover in 2015, ACH should have been 6 but was approximately 2.5 ACH, being the agreed derogation between the parties. This is a potentially deficient feature for the purposes of Glasgow III.

Room Air Pressure

6.55 In Appendix 2 of HTM 03-01 Part A (2007) and Table A1 of the Draft for Consultation SHTM 03-01 Part A (2009) there is no room air pressure value given for a general patient ward.

6.56 The RHC Haematology and Oncology COS states that it is not necessary to maintain a low level of positive pressure[92].

6.57 The M&E Clarification Log (2010 ItP) – Final had a comment which included room pressure differentials as noted on pages 3 and 4 of the Log where it is stated that "(rooms could also be at slightly negative pressure to corridor)". GGC agreed and noted negative pressure was to be created in the design solution[93]. In the absence of any requirement in the RHC COS and NHS Guidance there was no derogation required for room pressure. The room air pressure in this ward is **not** a potentially deficient feature for the purposes of Glasgow III.

Chilled Beams ("CBUs")

6.58 The Employer's Requirements stated that "the use of active chilled beams should be considered within all ward areas[94]. These were found to be installed in the ward's Day Care Units and the consulting rooms at handover in 2015.

6.59 As some CPs and others have challenged the use of CBUs in the QEUH and the use of CBUs in clinical areas are not recommended by the current edition of

[90] Queen Elizabeth University Hospital Review Report, June 2020, at para 4.5.24
[91] M & E Clarification Log (2010 ItP) – Final at pages 3 and 4.
[92] COS for NSGACL Haemat-Oncology NCH_iss1_rev Section 3.
[93] M & E Clarification Log (2010 ItP) – Final at pages 3 and 4.
[94] Employer's Requirements, Section 2.4 (Main Hospital Building), at paragraphs 2.4.3 [Chilled Beams].

SHTM 03-01 (2022), this is a potentially deficient feature for the purposes of Glasgow III.

Sealed Bedrooms

6.60 The RHC Haematology and Oncology COS did not require sealed bedrooms but in any event, it is understood by the Inquiry team that there are no bedrooms in Ward 2B as it is a day care unit and so this requirement is irrelevant. The ward had suspended ceilings rather than sealed ceilings. This is **not** a potentially deficient feature for the purposes of Glasgow III.

Airlock Entrance to Ward

6.61 The RHC Haematology and Oncology COS did not require an airlock entrance to ward in Ward 2B of the RHC and there was no airlock in place at handover in 2015. This is **not** a potentially deficient feature for the purposes of Glasgow III.

Backup AHU

6.62 The Employer's Requirements did not require a backup AHU in Ward 2B of the RHC and was not installed at handover in 2015. This is **not** a potentially deficient feature for the purposes of Glasgow III.

Pressure Monitoring System

6.63 The RHC Haematology and Oncology COS did not require a pressure monitoring system in Ward 2B for bedrooms and it was not installed at handover in 2015. This is **not** a potentially deficient feature for the purposes of Glasgow III.

Commissioning and Validation

6.64 At handover in 2015, commissioning of the ventilation system in the general wards had been carried out but there was no validation of the ventilation system. This is a potentially deficient feature for the purposes of Glasgow III.

6.65 Commissioning and validation of the ventilation system was carried out following the upgrade works in 2019.

Annual Verification

6.66 No annual verification of the ventilation system was undertaken post-handover. This is a potentially deficient feature for the purposes of Glasgow III.

Ward 2B - 2019 Upgrade Works

6.67 In 2019 upgrade works were carried out on Ward 2B, which resulted in HEPA filtration being installed. No works were carried out to increase the ACH which remained at the agreed derogated ACH of approximately 2.5 ACH. The room pressure which was at the same level as a general ward was not increased to positive pressure as no works were undertaken on this issue.

6.68 The 2019 upgrade works did not remove the CBUs. As some CPs and others have challenged the use of CBUs in the QEUH and the use of CBUs not recommended by the current edition of SHTM 03-01 (2022), this is a potentially deficient feature for the purposes of Glasgow III.

6.69 No upgrade works were undertaken in respect of sealed bedrooms and pressure monitoring system.

Ward 2B – 2024 Specification

6.70 In 2024 Ward 2B (Day Care Unit) was not in accordance with the NHS Guidance due to the ACH of 2.5 being below the required 6 ACH set out in Table A1 of the Draft for Consultation SHTM 03-01 Part A (2009). This is a potentially deficient feature for the purposes of Glasgow III.

QEUH Ward 4B - Bone Marrow Transplant (“BMT”) Unit

6.71 Ward 4B is the adult BMT Unit. The patients accommodated in this ward are considered the most vulnerable to infection and the highest risk in a healthcare setting.

6.72 Following a change order in 2013, it was decided that the Beatson West of Scotland Cancer Centre BMT Unit would move to the QEUH to be on a site with full ITU and HDU support.

6.73 Level 4 in the QEUH was originally intended to provide accommodation for Renal and Haemato-oncology. Ward 4B was to house haemato-oncology but it was agreed that this service would move to Ward 4C and the adult BMT Unit would be provided in Ward 4B.

6.74 No COS for the BMT Unit was provided. It appears that the Adult Haematology and Oncology COS was used for the BMT services and the design and construction.

6.75 Ward 4B was never designed to accommodate BMT patients. Paediatric patients were accommodated in this ward from November 2018 in order to enable works to be completed in the Schiehallion Unit.

6.76 The COS for the Adult Haemato-oncology states that:

> "high proportion of the patients receive chemotherapy and are immunocompromised, making them vulnerable to infection[95]."

6.77 The requirements in relation to ventilation were set out in the COS:

- no opening windows;
- no chilled beams;
- space sealed and ventilated;
- positive pressure to rest of hospital;
- all highly filtered air >90%, probably best HEPA; and
- adequate number of positive pressure sealed HEPA filtered side rooms for neutropenic patients as in the Beatson West of Scotland Cancer Centre.[96]

6.78 In July 2013, a Change Order was issued by GGC which confirmed that the BMT service would transfer to Ward 4B in the QEUH and the haematology patients that

[95] COS for NSGACL Haemato Oncology NSG_iss1_rev Section 1.
[96] COS for NSGACL Haemato Oncology NSG_iss1_rev, Section 1.

were originally planned to accommodate Ward 4B would move to Ward 4C.

6.79 The BMT Unit transferred from the Beatson West of Scotland Cancer Centre to the QEUH, Ward 4B on 6 June 2015. On 8 July 2015, the patients from Ward 4B returned to the Beatson Oncology Unit at Gartnavel Hospital. On 30 June 2018, following upgrade works, the patients returned to Ward 4B in the QEUH.

HEPA Filtration

6.80 The 2013 change order stated that the ward area required HEPA filtration to same standard as the current haemato-oncology ward[97]. The COS for haemato-oncology stated that patient bedrooms defined as 'side rooms for neutropenic patients' should have HEPA filtration. In any event, HTM 03-01 Part A (2007) guidance requires H12 (HEPA filtration) for neutropenic wards such as 4B.

6.81 On 23 June 2010, GGC notified[98] Multiplex in relation to a change to the Works Information which relates to HEPA filtration to remove HEPA filters for 8 single room wards in Haemato-oncology ward and this was implemented on or after 16 September 2010[99].

6.82 In July 2013, GGC instructed Multiplex to stop fit out works on Level 4 relating to HEPA filtration and other design changes[100] resulting in the work being halted due to a requested design change to be developed using the contract's RDD process.

6.83 Subsequently, on 2 October 2013, GGC accepted Multiplex's design and adaptation proposals for Level 4 (Haemato-oncology) of the QEUH in Zones 512, 513, and 514[101].

6.84 HEPA filtration was installed in ceiling diffusers in patient bedrooms at handover in 2015. A diffuser is a terminal at the end of the ventilation ductwork system which diffuses air into the room or provides a return air path for extracted air.

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[97] Change Number 2 on the Change Control Procedure Form for Ward 4B, dated 9 July 2013.
[98] PMI 21, 23 June 2010
[99] NEC Compensation Event CE5056 dated 16 September 2010.
[100] PMI 228, 2 July 2013.
[101] NEC Compensation Event CE10675 dated 2 October 2013. The location of zones 512, 513, and 514 is not known by the Inquiry team.

6.85 However, all other spaces in ward 4B including the corridor had no HEPA filtration. This is a potentially deficient feature for the purposes of Glasgow III.

Room Air Change Rate ("ACH")

6.86 The Adult Haematology and Oncology COS made no reference to air change rates[102].

6.87 In Appendix 2 of HTM 03-01 Part A (2007), the number of air changes for a neutropenic patient ward is stated to be 10 ACH. The same result is obtained from the Draft for Consultation SHTM 03-01 Part A (2009).

6.88 The Inquiry team considers that the effect of NHS Guidance was that 10 ACH was required in Ward 4B.

6.89 The M&E Clarification Log (2010 ItP) – Final recorded the ACH derogation referred to previously. However, the Inquiry team understands that Ward 4B was an agreed exception to this derogation, presumably because the COS for this ward expressly stated that no chilled beams should be used.

6.90 The Draft for Consultation SHTM 03-01 Part A (2009) required a standard of 10 ACH for critical/neutropenic areas. It was 6 ACH at handover in 2015. This is a potentially deficient feature for the purposes of Glasgow III.

Room Air Pressure

6.91 In Appendix 2 of HTM 03-01 (2007) Part A and Table A1 of the Draft for Consultation SHTM 03-01 the room air pressure is stated to be "+10 Pa" for neutropenic patient ward.

6.92 The Adult Haematology and Oncology COS refers to the ward having 'positive pressure to rest of hospital[103].

6.93 Accordingly, the Inquiry team considers that in relation to this ward, the effect of the NHS Guidance was that room air pressure of +10 Pa was required within the

[102] COS for NSGACL Haemato Oncology NSG_iss1_rev Section 1.
[103] COS for NSGACL Haemato Oncology NSG_iss1_rev Section 1.

patient bedrooms in Ward 4B. At handover, the room pressure differentials were found to be 3-4 Pa +ve relative to the ward corridor. This is a potentially deficient feature for the purposes of Glasgow III.

Chilled Beams ("CBUs")

6.94 The Adult Haematology and Oncology COS (which formed part of the Employer's Requirements) stipulated that there be no CBUs [104]. Accordingly, no CBUs were to be installed within Ward 4B of the QEUH and there were none at handover in 2015. This is **not** a potentially deficient feature for the purposes of Glasgow III.

Sealed Bedroom/Ensuites

6.95 The Adult Haematology and Oncology COS (which formed part of the Employer's Requirements) stipulated that "space sealed"[105] which it is understood by the Inquiry team to mean the bedrooms and ensuites were to be sealed.

6.96 This was not the case at handover in 2015 as the ward had suspended ceilings. This is a potentially deficient feature for the purposes of Glasgow III.

Airlock Entrance to Ward

6.97 The Adult Haematology and Oncology COS did not require an airlock entrance to Ward 4B of the QEUH and no airlock entrance was installed at handover in 2015. This is **not** a potentially deficient feature for the purposes of Glasgow III.

Backup AHU

6.98 The Employer's Requirements did not require a backup AHU in Ward 4B of the QEUH and one was not installed at handover in 2015. However, given the terms of the 2017 SBAR upgrade works, the absence of one at handover is a potentially deficient feature for the purposes of Glasgow III.

[104] COS for NSGACL Haemato Oncology NSG_iss1_rev, Section 1.
[105] COS for NSGACL Haemato Oncology NSG_iss1_rev, Section 1.

Pressure Monitoring System

6.99 The Adult Haematology and Oncology COS did not require a pressure monitoring system for the ward's bedrooms. However, given that a pressure monitoring system was also installed during the 2015 upgrade works, the absence of one at handover is a potentially deficient feature for the purposes of Glasgow III.

Commissioning and Validation

6.100 At handover in 2015, commissioning of the ventilation system in the general wards had been carried out but there was no validation of the ventilation system. This is a potentially deficient feature for the purposes of Glasgow III

6.101 As shown in in the table for Ward 4B in Appendix 2, commissioning and validation of the ventilation system was carried out following the upgrade works in July 2015 and September 2017.

Ward 4B July 2015 Upgrade Works

6.102 In July 2015, upgrade works were undertaken in Ward 4B which resulted in some changes to certain ventilation issues. The room pressure of 3-4 Pa was increased to approximately 5+ Pa. Bedrooms which had suspended ceilings of the patient bedrooms were sealed by the use of plasterboard although the ensuites remained with suspended ceiling tiles. A pressure monitoring system was also installed during the 2015 upgrade works. The ACH rates of below 10 ACH, room pressure readings below 10 Pa and lack of HEPA filtration to the corridor remained a potentially deficient features for the purpose of Glasgow III.

Ward 4B December 2015 Recommendations NSS SBAR

6.103 In December 2015 an SBAR[106] was issued by Health Protection Scotland ("HPS") which recommended the following:

[106] Support had been requested from HPS by GGC regarding an assessment of the ventilation requirements which would allow GGC to provide a safe environment for the care of BMT patients. HPS provided an SBAR that made several recommendations.

- HEPA filtered air into the rooms;
- Ideally the corridor should also be supplied with HEPA filtered air;
- 10 ACH;
- 10 Pa;
- sealed ceilings within the bedrooms and ensuites; and
- continuous pressure monitoring system.

6.104 The SBAR December 2015 Recommendations would have brought the ward into line with the Draft for Consultation SHTM 03-01 Part A (2009) requirements.

Ward 4B - September 2017 Upgrade Works

6.105 The 2017 upgrade works resulted in the ensuites becoming sealed by the use of plasterboard which the Inquiry team understands to be partial implementation of a PMI issued by GGC on 9 March 2016[107].

Ward 4B October 2017 Recommendations NSS SBAR

6.106 In October 2017 an SBAR was issued by HPS which recommended the following:

- HEPA filtered air into the rooms;
- ideally the corridor should also be supplied with HEPA filtered air;
- 10 ACH;
- 10 Pa;
- sealed ceilings within the bedrooms and ensuites;
- one air handling unit required to be addressed (e.g. planned shut downs or unplanned events (such as motor failures or power failures); and

[107] PMI 471 dated 9 March 2016.

- continuous pressure monitoring system.

6.107 The 2017 SBAR mirrored the 2015 SBAR with one change which was to address the one air handling unit. In other words, to install a backup AHU. It should also be noted that the SBAR stated that:

> "The validation of the entire system should be as detailed in the generic guidance given in SHTM 03-01 part A and verification of the entire system should be as outlined in SHTM 03-01 part B. These may have to be adapted to meet the requirements of this situation.[108]"

Ward 4B – 2024 Specification

6.108 In 2024 Ward 4B does not have HEPA filtered corridors and the room air change rate is not 10 ACH but is 6 ACH. These are potentially deficient features for the purpose of Glasgow III.

QEUH Ward 4C Haemato-oncology & Renal

6.109 Ward 4C is the adult Haemato-oncology and renal ward. The Haemato-oncology patients accommodated in Ward 4C are immunocompromised and require specialist ventilation.

6.110 Level 4 in the QEUH was originally intended to provide accommodation for Renal and Haemato-oncology. Haemato-oncology was to be in Ward 4B, however, the service was moved to Ward 4C following the transfer of the BMT Unit to Ward 4B.

6.111 Ward 4C was never designed to accommodate Haemato-oncology patients.

6.112 The Inquiry team considers that the Haemato-oncology COS applies to this ward because neutropenic patients were already allocated to this ward before handover[109]. This resulted in a section of the ward becoming in effect a neutropenic patient ward pre-handover bringing with it the more onerous

[108] NSS SBAR October 2017 Recommendations.
[109] COS for NSGACL Haemato Oncology NSG_iss1_rev; COS for NSGACL Renal NSG_iss1_rev; COS for NGACL Renal Dialysis NSG_iss1_rev.

ventilation requirements for a neutropenic patient ward set out in the Draft for Consultation SHTM 03-01 Part A (2009).

HEPA Filtration

6.113 In Appendix 2 of HTM 03-01(2007), there are two tables (tables 2 and 3) which summarise the design conditions for specific wards and rooms. A specific ward listed is a neutropenic patient ward and the supply filter grade in table 2 required is "H12" while in table 3 a haematology/oncology ward is "BS EN 1822 – EPA12". These filter grade levels are classified as HEPA filters. The same outcome arises from Table A1 of the Draft for Consultation SHTM 03-01 Part A (2009) where a neutropenic patient ward must have H12 (HEPA filter).

6.114 The Adult Haematology and Oncology COS expressly required highly filtered air >90% and HEPA filtered side rooms for neutropenic patients. In any event, HTM 03-01 Part A (2007) guidance would require H12 (HEPA filtration) for neutropenic wards such as 4C[110].

6.115 At handover in 2015, HEPA filtration should have been installed within Ward 4C but was not. This is a potentially deficient feature for the purposes of Glasgow III.

Room Air Change Rate ("ACH")

6.116 The Adult Haematology and Oncology COS makes no reference to air change rates[111].

6.117 In Appendix 2 of HTM 03-01 Part A (2007), the number of air changes for a neutropenic patient ward is stated to be 10 ACH. Accordingly, the Inquiry team considers that in this ward the effect of the NHS Guidance was that 10 ACH was required in Ward 4C.

6.118 The M&E Clarification Log (2010 ItP) – Final includes Multiplex's proposal of 40 litres of air per second per single room, on the assumption a patient and four others occupy a room (this is equivalent to 8 litres per second per person)

[110] COS for NSGACL Haemato Oncology NSG_iss1_rev, Section 1.
[111] COS for NSGACL Haemato Oncology NSG_iss1_rev, Section 1.

(approx. 2.5 ACH for single bedrooms) which is less than NHS Guidance required [112]. GGC confirmed agreement to this proposal[113].

6.119 The Draft for Consultation SHTM 03-01 Part A (2009) standard of 10 ACH for critical/neutropenic areas, was derogated to 2.5 ACH. This is a potentially deficient feature for the purposes of Glasgow III.

Room Air Pressure

6.120 In Appendix 2 of HTM 03-01 of Part A (2007) and Table A1 of the Draft for Consultation SHTM 03-01 Part A (2009) the room air pressure is stated to be "+10 Pa" for neutropenic patient ward.

6.121 The Adult Haematology and Oncology COS refers to the ward 'positive pressure to rest of hospital[114].

6.122 Accordingly, the Inquiry team considers that in relation to this ward the effect of the NHS Guidance was that room air pressure of +10 Pa within the patient bedrooms in Ward 4C.

6.123 The M&E Clarification Log (2010 ItP) – Final also derogated from room pressure differentials as noted on pages 3 and 4 of the Log where it is stated that "(rooms could also be at slightly negative pressure to corridor)". GGC agreed and noted negative pressure was to be created in the design solution[115]. This was a derogation of the +10 Pa for the Ward 4C. This is a potentially deficient feature for the purposes of Glasgow III.

Chilled Beams ("CBUs")

6.124 The Adult Haematology and Oncology COS prohibited CBUs for a ward dealing with a neutropenic patient group[116] but there was an agreed derogation in the Final M & E Clarification Log[117] to allow CBUs, and these were found to be

[112] Queen Elizabeth University Hospital Review Report, June 2020, at para 4.5.24
[113] M & E Clarification Log (2010 ItP) – Final at pages 3 and 4
[114] COS for NSGACL Haemato Oncology NSG_iss1_rev, Section 1., Section 1.
[115] M & E Clarification Log (2010 ItP) – Final at pages 3 and 4.
[116] COS for NSGACL Haemato Oncology NSG_iss1_rev, Section 1., Section 1.
[117] M & E Clarification Log (2010 ItP) – Final at page 3

installed in Ward 4C at handover in 2015.

6.125 As some CPs and others have challenged the use of CBUs in the QEUH and the use of CBUs not recommended by the current edition of SHTM 03-01 (2022). This is a potentially deficient feature for the purposes of Glasgow III.

Sealed Bedroom/Ensuites

6.126 The Adult Haematology and Oncology COS stipulated that the ward should have "space sealed"[118].

6.127 Accordingly, the Inquiry team considers that in this ward the effect of the Adult Haematology and Oncology COS was that sealed bedrooms and ensuites were required in Ward 4C, but this was not the case at handover in 2015 as the ward had suspended ceilings. This is a potentially deficient feature for the purposes of Glasgow III.

Airlock Entrance to Ward

6.128 The Adult Haematology and Oncology COS did not require an airlock entrance to Ward 4C of the QEUH and there was no airlock in place at handover in 2015. This is a potentially deficient feature for the purposes of Glasgow III.

Back Up AHU

6.129 The Employer's Requirements did not require a backup AHU in Ward 4C and one and was not installed at handover in 2015. This is **not** a potentially deficient feature for the purposes of Glasgow III.

Pressure Monitoring System

6.130 The Adult Haematology and Oncology COS (which formed part of the Employer's Requirements) did not require a pressure monitoring system in Ward 4C and was not installed at handover in 2015. However, this ward should have had +10Pa which would require pressure monitoring, this is a potentially deficient feature for

[118] COS for NSGACL Haemato Oncology NSG_iss1_rev, Section 1., Section 1.

the purposes of Glasgow III.

Ward 4C Commissioning and Validation

6.131 At handover in 2015, commissioning of the ventilation system in Ward 4C had been carried out but there was no validation of the ventilation system. This is a potentially deficient feature for the purposes of Glasgow III.

Ward 4C Annual Verification

6.132 The Inquiry team understands that no annual verification of the ventilation system was carried out post-handover until circa 2018 or 2019. This is a potentially deficient feature for the purposes of Glasgow III.

Ward 4C – 2024 Specification

6.133 In 2024 Ward 4C is not in accordance with the Draft for Consultation SHTM 03-01 Part A (2009) or the 2013 version of the SHTM 03-01 Part A. The only mitigating measures are freestanding mobile HEPA filter units in both the bedrooms and corridors and recirculation air scrubber fans (Camfil Camcleaner 400 concealed fan units) in the ensuites. Ward ACH rates remain at 2.5, room pressure is 0 or-ve, chilled beams are installed and suspended ceilings are present throughout. These are all potentially deficient features for the purposes of Glasgow III.

QEUH Ward 6A - Decanted location of the Schiehallion Unit

6.134 This ward was originally designated as an adult rheumatology ward and was designed as a general ward; it had no specialist ventilation requirements. On 26 September 2018 the original patient group was moved to accommodate haemato-oncology paediatric patients from Ward 2A in the RHC that moved into the ward during November 2018. The environmental conditions on Ward 6A in the QEUH were the same as those found in Ward 2A in the RHC.

6.135 After decant, the neutropenic patients from RHC were in a ward designed for general patients without the more onerous ventilation requirements in accordance with the Draft for Consultation SHTM 03-01 Part A (2009) guidance. The arrival of the neutropenic patients post-handover in the ward turned the general ward into a

neutropenic ward with the more onerous ventilation requirements. Non-extensive upgrade works were undertaken throughout 2019. On 9 March 2022, the paediatric patients returned to Ward 2A in the RHC. The decant to Ward 6A is a potentially deficient feature for the purposes of Glasgow III.

HEPA Filtration

6.136 In Appendix 2 of HTM 03-01 Part A (2007), a general ward's filter requirement is non-HEPA, SUP2.

6.137 Accordingly, NHS Guidance did not require HEPA filtration in the Ward 6A of the QEUH and no HEPA filtration was installed at handover. At the time of handover this was **not** a potentially deficient feature.

Room Air Change Rate ("ACH")

6.138 In both Appendix 2 of HTM 03-01 Part A (2007) and Appendix 1 of Draft for Consultation SHTM 03-01 Part A (2009) the number of air changes for general wards is stated to be 6 ACH. Accordingly, the Inquiry team considers that for general wards the effect of the NHS Guidance was that 6 ACH was required in the General Wards of the QEUH.

6.139 The M&E Clarification Log (2010 ItP) – Final includes Multiplex's proposal of 40 litres of air per second per single room, on the assumption a patient and four others occupy a room (this is equivalent to 8 litres per second per person) (approx. 2.5 ACH for single bedrooms) which is less than NHS Guidance required[119]. GGC confirmed agreement to this proposal[120].

6.140 As discussed above the Draft for Consultation SHTM 03-01 Part A (2009) standard of 6 ACH for general wards was derogated to 2.5 ACH. This is a potentially deficient feature for the purposes of Glasgow III.

[119] Queen Elizabeth University Hospital Review Report, June 2020, at para 4.5.24
[120] M & E Clarification Log (2010 ItP) – Final

Room Air Pressure

6.141 In Appendix 2 of HTM 03-01 Part A (2007) and Table A1 of Draft for Consultation SHTM 03-01 Part A (2009), the room air pressure is stated to be "0 or -ve" for a single room.

At handover in 2015 the room pressure was "0 or slightly -ve relative to the corridor". This is a potentially deficient feature for the purposes of Glasgow III.

Chilled Beams ("CBUs")

6.142 The Employer's Requirements stated that "the use of active chilled beams should be considered within all ward areas[121]".. The NHS Guidance[122] required that if using CBUs they be positioned carefully to avoid cold draughts, control settings ensure that external elements of beam are always above dewpoint and should be easily accessible for maintenance. At handover, there were CBUs installed in the wards.

6.143 As some CPs and others have challenged the use of CBUs in the QEUH and the use of CBUs not recommended by the current edition of HTM 03-01. This is a potentially deficient feature for the purposes of Glasgow III.

Ward 6A Commissioning and Validation

6.144 At handover in 2015, commissioning of the ventilation system in Ward 6A had been carried out but there was no validation of the ventilation system. This is a potentially deficient feature for the purposes of Glasgow III.

Ward 6A Annual Verification

6.145 The Inquiry team understands that no annual verification of the ventilation system was carried out post-handover until circa 2018 or 2019. This is a potentially deficient feature for the purposes of Glasgow III.

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[121] Employer's Requirements, Section 2.4 (Main Hospital Building), at paragraphs 2.4.3 [Chilled Beams].
[122] Draft for Consultation SHTM 03-01 Part A at p.26 and HTM 03-01 Part A (2007) at p.11.

Ward 6A – 2019 Upgrade Works

6.146 The transfer of patients from Ward 2A on 26 September 2018 effectively changed Ward 6A from a general ward to a ward for neutropenic patients with the more onerous requirements that brings with it such as HEPA filtration, 10 ACH, and 10+ Pa [123].

6.147 Throughout 2019, upgrade works were undertaken to Ward 6A which resulted in some changes to certain ventilation issues. Mitigation measures were introduced concerning HEPA filtration with 3 portable HEPA filter units being placed in rooms 20, 21, and 23. In August 2019, air scrubber fans (Camfil Camcleaner 400 concealed fan units) were installed in the ceiling space of patient en-suite rooms within the ward. Notwithstanding these changes the ventilation of Ward 6A whilst it was used as a decant for the Schiehallion Unit remains a potentially deficient feature for the purposes of Glasgow III.

6.148 On 2 September 2019, flexible push fit connectors were changed relating to the CBUs.

APPENDIX 1: NHS GUIDANCE RELEVANT FOR THIS PPP12

- HTM 03-01 Part A: Specialised ventilation for healthcare premises Part A (2007)
- HTM 03-01 Part B: Specialised ventilation for healthcare premises Part B (2007)
- Draft for Consultation SHTM 03-01 Part A: Specialised ventilation for healthcare premises (2009)
- Draft for Consultation SHTM 03-01 Part B: Specialised ventilation for healthcare premises (2010)
- SHTM 03-01 Ventilation for healthcare premises Part A – Design and validation (2013)
- SHTM 03-01 Part A The concept, design, specification, installation and

[123] Draft for Consultation SHTM 03-01 Part A.

acceptance testing of healthcare ventilation systems (2022)

APPENDIX 2: PPP12 VENTILATION TABLE

See PPP12 Ventilation Table in Excel format which is produced separately.

APPENDIX 3: M&E CLARIFICATION LOG (2010 ItP) – FINAL EXCERPT

This document is 'The M & E Clarification Log (2010 ItP) – FINAL'

Item	Add	Omit	Board Comment	Status	Brookfield Comment	Board Comment 2	Agreed Position 2009 Contract	2010 ItP Comments	Agreed Position 2010 ItP
ER 2/1									
	-	-	Ward Air change to be 6AC/HR, currently shown as 2.5AC/HR which is not in compliance with SHTM 03-01.	Agreed	Brookfield proposal as outlined within the bid submission is to incorporate chilled beams as a low energy solution to control the environment which do not rely on large volumes of treated air or variable natural ventilation. All accommodation is single bedrooms and therefore the need for dilution of airborne microbiological contamination should be reduced (rooms could also be at slightly negative pressure to corridor). Providing 6 air changes is energy intensive and not necessary.		**Agreed** The proposal is accepted on the basis of 40 litres per second per single room (8 litres per second per second) for one patient and four others. Joint review to be carried out between the Board and Brookfield of the energy model to determine any impact on the energy target/BREEAM rating. Brookfield, however, remain responsible for achievement of the energy target/BREEAM, with £250,000 added to the contract sum in this regard. Negative pressure to be created in the design solution.	Energy model based on the agreed 2009 position.	Agreed

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